ERIC Document Resume	See Instruction Sheet	DATE OF RESUME	DATE RECEIVED

A. PUBLICATION DATA

1. ERIC NUMBER	2. ORIGINATOR CONTROL NO(S).	3. IDENTIFICATION NO.
ED001128	NA	CR 1067

4. AUTHOR(S): Stuart, Fred & Curtis, H. A.

5. TITLE OF DOCUMENT ABSTRACTED: The Pinellas County Experiment: Climate Controlled Schools

6. PUBLICATION TITLE: NA

7. EDITOR(S): NA

8. PLACE OF ORIGIN
Pinellas County Board of Public Instruction
ST. Clearwater, Florida
CITY, STATE
TELE. EXT
INST/LOC CODE

9. PUBLISHER OR SOURCE Cooperative Research Program, Office of Education, Dept. of Health, Education, & Welfare, Wash., D.C.

10. VOL.	11. PAGES	12. MO./YR.	13. TOTAL PP.
NA	NA	64	280

DO NOT WRITE IN SPACE BELOW

MICROFILM COPY AVAILABLE
YES ☒ NO ☐

COPYRIGHT GRANTED
YES ☐ NO ☒

COPYRIGHT RELEASE FILED
YES ☐ NO ☐

TYPE OF REPORT
PROPOSAL ☐
IN-PROGRESS ☐
FINAL ☒
FOLLOW-UP ☐

OTHER ERIC REFERENCES:

ERIC SATELLITE CODE

B. INDEXING DATA

14. SUBJECT AREA

15. TYPE OF ENDEAVOR experimental research

16. INDEXING TERMS (6-12)

		education experimentation	classroom effect
		pupil achievement	health effect
air conditioning	school construction	pupil comfort	discipline effect
climate control	education research	non-climate control	comfort effect

17. ABSTRACT (MAX. 250 WORDS)

A comparison was made of one climate controlled school with one or more non-climate controlled schools of similar size with respect to factors of cost and outcomes in the Pinellas County, Florida Public School System. Each of the four schools studied had the following similarities: location, cost of construction, occupancy rate, and operating costs. Construction differed somewhat advantageously for the climate controlled school which in turn helped to reduce its operating costs. Comfort indices developed through temperature and humidity readings and pupil questionnaires showed the climate controlled schools to have a higher degree of relative comfort. Achievement gains were greater in the climate controlled school in four comparisons and equal in two comparisons. In no case were they less than in non-climate controlled schools. Differences in discipline or health did not seem to be significant factors. Conservative interpretations of the data, are favorable to the compact climate controlled school. There was no evidence that the compact climate controlled school adversely affected the school program, the students, or the teachers.

ERIC No.

18. SOURCE OF ABSTRACT

C. FUNDING DATA

19. SUPPORTING ORGANIZATION

20. DIVISION OR DEPT.

21. CONTRACT NO.

PROJECT NO.

22. TOTAL COST OF PROJECT

23. DURATION OR PROJECT

U.S. Department of Health, Education, and Welfare
Office of Education

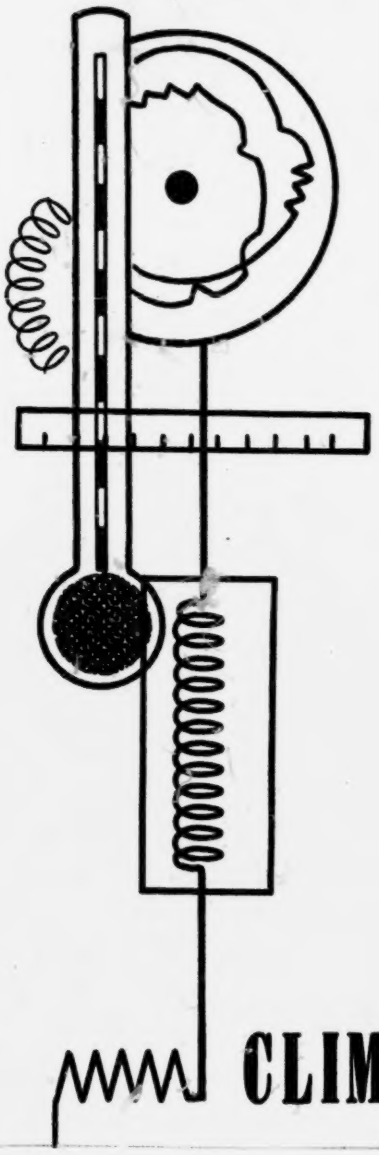
5

ERIC Form 1

1067

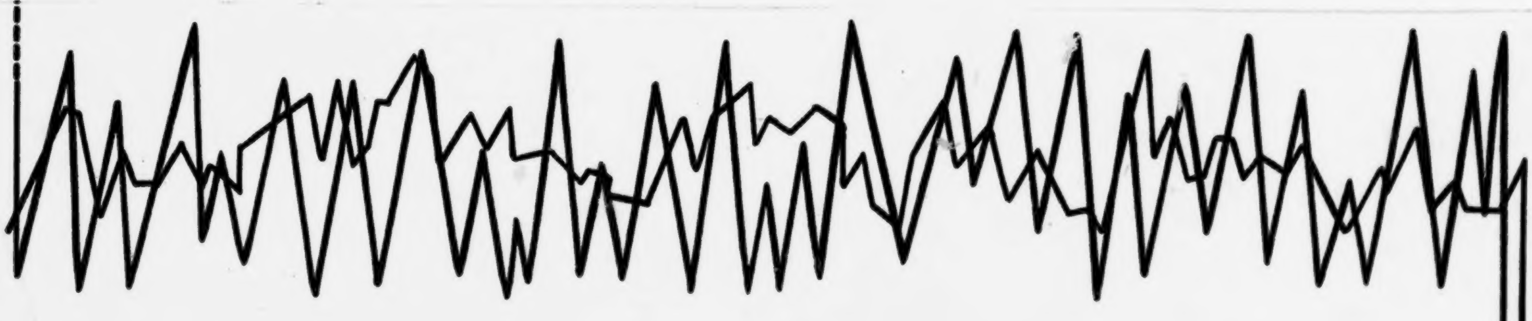
ED001128

THE PINELLAS COUNTY EXPERIMENT



CLIMATE CONTROLLED SCHOOLS

REPRINTED BY PERMISSION
U. S. DEPARTMENT OF HEALTH, EDUCATION AND WELFARE
OFFICE OF EDUCATION
THIS DOCUMENT HAS BEEN PRINTED EXACTLY AS RECEIVED FROM THE PERSON OR ORGANIZATION ORIGINATING IT. POINTS OF VIEW OR OPINIONS STATED DO NOT NECESSARILY REPRESENT OFFICIAL OFFICE OF EDUCATION POSITION OR POLICY.



FRED STUART & H.A. CURTIS

PINELLAS COUNTY BOARD OF PUBLIC INSTRUCTION
FLOYD T. CHRISTIAN, SUPERINTENDENT

A DIGEST OF

CLIMATE CONTROLLED AND NON-CLIMATE CONTROLLED SCHOOLS:

An Evaluative Study Conducted in Pinellas County, Florida.

FRED STUART, ED. D.
Project Supervisor
Pinellas County Public Schools
Clearwater, Florida

H. A. CURTIS, ED. D.
Research Consultant
Florida State University
Tallahassee, Florida

THE RESEARCH REPORTED HEREIN WAS PERFORMED PURSUANT TO A CONTRACT WITH THE UNITED STATES OFFICE OF EDUCATION, DEPARTMENT OF HEALTH, EDUCATION AND WELFARE;

AND

THIS REPORT CONTAINS THE RESULTS OF COOPERATIVE RESEARCH BETWEEN THE AMERICAN SOCIETY OF HEATING, REFRIGERATING, AND AIR CONDITIONING ENGINEERS, THE PINELLAS COUNTY BOARD OF PUBLIC INSTRUCTION AND THE FLORIDA STATE UNIVERSITY.

COOPERATIVE RESEARCH PROJECT NO. 1067
ASHRAE NO. R.P.26

Floyd T. Christian, Superintendent
Pinellas County Board of Public Instruction
Clearwater, Florida

1964

Copies of the complete report (260 pages) are available for $2.00 from:

Supervisor of Climate Control
Pinellas County Board of Public Instruction
1895 Gulf to Bay Blvd.
Clearwater, Florida

DIGEST

A. The Purpose and Characteristics of the Study

The purpose of this study was to compare one climate controlled school with one or more non-climate controlled schools of similar size with respect to certain factors of cost and with respect to certain outcomes. These schools are units of the Pinellas County, Florida, public school system and were in normal operation throughout the study.

The investigators studied the normal operation of one climate controlled school during two academic years and two summer terms and the normal operation of two non-climate controlled schools during the same two academic years. They also studied a third non-climate controlled school operating simultaneously with the summer terms of the climate controlled school. The purpose was to compare the cost of construction of the climate controlled building with that of one non-climate controlled school which was built at approximately the same time and to determine the similarities and differences between the climate controlled and non-climate controlled schools with respect to operating costs and general quality and the comfort, achievement, conduct and health of the students.

Since the study dealt with schools under normal operation, the investigators were not at liberty to manipulate experimental variables while holding other variables constant. The schools investigated were those which were available and the universe of which they may be considered a sample cannot be specified. The schools differed among themselves in respects other than their internal climates. Basically, the research was a case study of the schools involved. The investigators have refrained from drawing generalizations encompassing schools in other places or in other times. Through their analyses, they have attempted to ascertain and to report the pertinent facts. The applications of their findings to other situations must be the responsibility of the reader and exercised at his discretion.

B. Setting and Background

Pinellas County is situated on Florida's middle west coast and occupies a peninsula between the Gulf of Mexico to the west and Tampa Bay to the east. During the typical year there are five months, May - September, during which temperatures near 90°F are common and the relative humidity is high, morning ground fogs and afternoon thunder showers being common. A few frosts and light freezes occur during the winter months, December - February, and heat is required in buildings. During two fall and two spring months, the temperatures are warm to balmy.

There are prolonged periods of the school year during which inside temperatures are in excess of 80°F, and schoolroom temperatures higher than 90°F are all too common.

The county school system constructed Oak Grove Junior High, a fully climate controlled school, as an experimental plant. At approximately the same time it constructed Pinellas Park Junior High, an open campus-type plant, as a control school. The latter was heated with residential type gas fired furnaces situated between each pair of adjacent classrooms. Ceiling fans in the hallways augmented the natural flow of air through the windows. Both buildings had a design enrollment of 930 students.

Preliminary investigation indicated that the differences between the socio-economic levels of the communities in which these schools were located and the difference between the levels of academic attainment of their students were such that an additional control school should be included in the study. It also did not seem to be administratively feasible to conduct summer school in Pinellas Park. For these reasons, Tyrone Junior High was added as a second control school in all academic year studies and Northeast became the control school for summer studies.

C. Cost of Construction

The gross costs of school plants include factors unrelated to the building proper. These include land costs, land fills and soil stabilization, provisions for sewage disposal, sidewalks, streets, curbing, etc. By eliminating these variables from the gross cost of each school plant, the net cost of comparable buildings was obtained. The size of each building was computed on the basis of A. S. A. designations for the comparison of areas and on the basis of A. I. A. definitions for the comparison of areas, volumes and their unit costs. In summary form, the results were:

	Oak Grove	Pinellas Park
Cost of comparable buildings	$699,184.97	$713,850.73
Gross area in square feet:		
A. S. A.	61,741	66,398
A. I. A.	70,484	74,678
Gross volume in cubic feet:		
A. I. A.	1,200,782	1,154,629
Unit Cost:		
A. I. A. sq. ft.	$9.92	$9.56
A. I. A. cu. ft.	0.58	0.62

The cost of these buildings did not differ by an amount that would be considered significant by those generally responsible for school construction. By way of comparison, Tyrone, a 24 classroom plant was constructed in 1955 at a cost of $632, 352. 47. Allowing for some inflation in building costs over the five year interval, Tyrone's cost in 1960 dollars did not differ greatly from that of Oak Grove. The data will not support a general conclusion about the relationship between the cost of climate controlled and non-climate controlled school buildings. The cost analysis makes it clear, however, that the cost of the mechanical equipment required for climate control was offset by savings resulting from the compacting of the building made possible by full control of the interior climate.

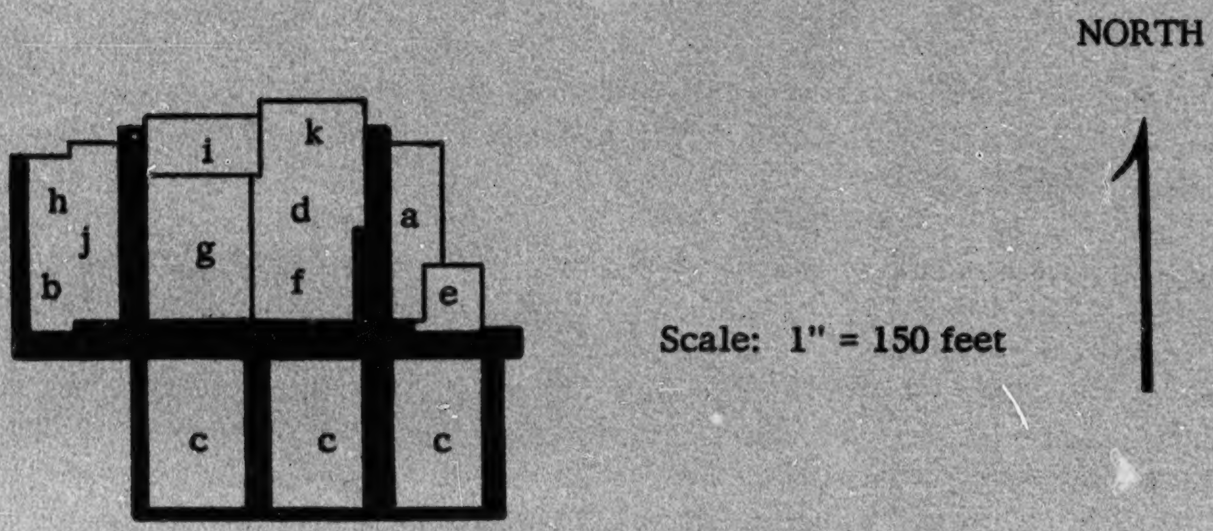
D. Characteristics of the Buildings

The general design, including the arrangement of classrooms and other functional units of the three plants, is shown in Figure A. All are single story buildings.

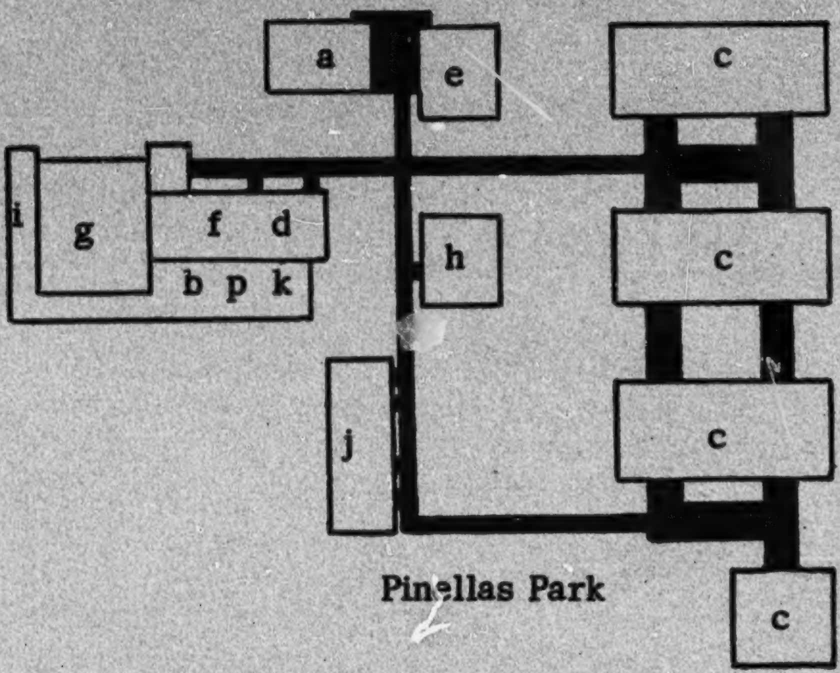
The Oak Grove plant has six sections under three roofs, the sections being separated by 12-foot and 22-foot covered malls. The plant's equipment room supplies hot or chilled water for climate control. Fresh air is available to all areas through air chases or outside walls. Solar protection is variously provided by screens, covered walkways, and roof overhangs. Ceilings are of acoustical tile. There are 4-inch mineral wool insulation batts and a 9-inch air space between ceiling and roof. The roof, supported by steel bar joists, is constructed of $\frac{1}{2}$" gypsum form board overlaid with 5-ply roofing topped with bitumen and gravel.

The Pinellas Park plant has eight separate sections, each under its own roof. These are connected by 8-foot walkways covered by roofs 9 feet high. The classroom sections are eight room pods. In each pod, four rooms have double external exposure. Four are in pairs, each room of which has a single north or south exposure. Folding doors that may be opened for cross ventilation separate the two rooms of each pair. Residential type gas heaters are situated between adjacent rooms and exhaust fans are located in ceilings of hallways. All pods are protected by a 5-foot overhang plus the protection afforded by connecting malls. Its ceiling and roof consist of exposed prestressed concrete joists which support 2-inch Tectum deck covered with a 5-ply built up roof. All roofs are flat.

The Tyrone plant consists of thirteen sections under six roofs. It has eight classroom sections of four rooms each. The several sections are heated by hot water from a central boiler supplied to finned radiation


NORTH
Scale: 1" = 150 feet
k
i
h
j
b
g
d
f
a
e
c
c
c

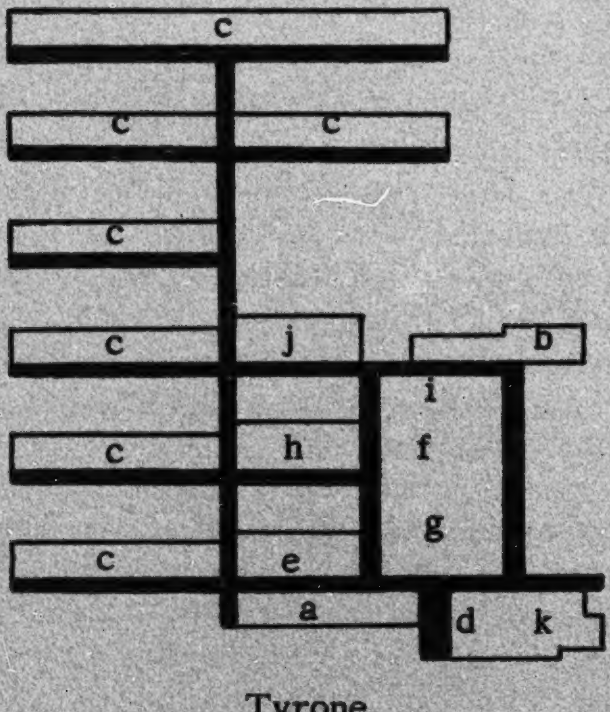
Oak Grove


a
e
c
i
g
f
d
b p k
h
c
j
c
c

Pinellas Park

Key to school areas:

a - administration
b - band
c - classrooms
d - dining area
e - library
f - stage
g - gymnasium
h - home economics
i - lockers
j - shop
k - kitchen


c
c
c
c
c
j
b
i
c
h
f
g
c
e
a
d
k

Tyrone

Figure A -- Plant Layout of Each School.

units or to suspended unit heaters. The north exposure of each unit is protected by a 3-foot overhang and the south by a 10-foot covered walkway. Connecting walks between sections are 10 feet wide and covered with a roof 10 feet high. No systematic provision is made for the mechanical ventilation of this plant. Ceilings are of acoustical tile with 3 inch mineral wool batts between ceiling and roof. The roof consists of a built up layer over a 2 inch gypsum (reinforced) poured deck on ½ inch sheet rock on steel joists.

The total wall and glass areas used in U factor calculations are:

	Wall	Glass
Oak Grove	35,187	6,649
Pinellas Park	22,658	12,174
Tyrone	48,839	12,909

The buildings have an assortment of skydomes and each has its distinctive lighting system. Suspended fluorescent fixtures are used in all areas.

E. Occupancy

In addition to serving the students and school personnel during the academic year, the schools were variously used by adult groups in their communities for social, recreational and religious purposes. The extent of the use of each building affected the cost of its operation and affected other factors considered in this study.

The total use of each of these buildings, in each 12-months period, July 1 - June 30, expressed in terms of Man-Hours was:

	1961-62	1962-63
Oak Grove	1,017,534	1,084,257
Pinellas Park	1,437,565	1,545,235
Tyrone	1,898,264	2,001,682

Nine months academic year use by all groups totaled:

	1961-62	1962-63
Oak Grove	987,054	1,046,769
Pinellas Park	1,434,245	1,540,835
Tyrone	1,894,304	1,996,602

The most significant differences in terms of space utilization occurred during the summer months. The MHU during summers for each building was:

	1961-62	1962-63
Oak Grove	30,480	37,488
Pinellas Park	3,320	4,400
Tyrone	3,960	5,080

F. Operating Costs

Any modern school plant is a complex system, or more properly, a complex of systems, and the cost of its operation is a complex function of many variables, most of which are intricately interrelated, only a few of which are independent, and some of which are very real but well concealed. The design of a plant affects the cost of cleaning it. Economies taken and materials used in its construction affect the cost of heating it. The quality of the service received is related, but not necessarily positively, to cost. The number of people using the plant, the kinds of uses made, and the way it is used affect costs. The kinds of energy consumed, the efficiency of the equipment systems and the intricacies and variability of rate structures affect costs. Neglect, or delay in making repairs conceals operating costs. All of these considerations, and many more, entered into the cost of operating these buildings.

The net operating cost, based upon sums actually disbursed, for each of the three buildings during each of two fiscal years was:

	1961-62	1962-63
Oak Grove	$36,548.26	$37,577.55
Pinellas Park	37,604.63	39,742.38
Tyrone	35,186.50	35,317.58

All buildings consumed electricity. Oak Grove utilized natural gas during both years. Tyrone used natural gas during the second year, but used LP gas during the first. Pinellas Park used LP gas both years. Fuel oil was used by Tyrone and Pinellas Park, but not by Oak Grove. The unit costs of all forms of energy varied from time to time during the project and, at any given time, the unit costs of some differed from building to building. The dollar cost of all forms of energy for each school for each full year was:

	1961-62	1962-63
Oak Grove	$9,310.94	$9,917.06
Pinellas Park	9,943.66	11,817.90
Tyrone	6,232.53	7,053.21

The external temperature influences the total cost of energy by affecting the amount consumed for cooling and heating. The external temperatures were such that the number of cooling and heating degree days during each academic year was:

	1961-62	1962-63
Cooling degree days	2,029	1,708
Heating degree days	287	610

Conditions requiring most of the expenditure of energy for heat were concentrated in a three months period during the first year but extended over five months during the second. Equipment that inefficiently produced and construction that inefficiently conserved heat contributed to the greater increases in the amounts of energy consumed in some buildings than in others during the second year. This accounts at least in part for the differences between the amounts of energy shown below:

Energy in Mbtu's

	1961-62	1962-63	Diff.
Oak Grove	3,467,353	3,598,152	130,799
Pinellas Park	3,345,737	4,517,012	1,171,275
Tyrone	1,756,229	1,954,963	198,734

The pattern of use of each of these buildings differed from that of the others. The principal difference which influenced operating costs was the use of Oak Grove, the climate controlled building, for summer school and for professional conferences during the summer periods. Based upon the nine months period of the academic year, the cost of all forms of energy used in each building amounted to:

	1961-62	1962-63
Oak Grove	$7,588.56	$8,093.40
Pinellas Park	8,616.05	10,512.43
Tyrone	5,666.34	6,331.57

There were operating economies which were associated with the compact, climate controlled building upon which a dollar value could not be placed. These include:

A. Reduction in the man-hours of labor required to sweep the open and covered walkways between buildings and police grounds adjacent to such walkways.

B. Reduction in breakage and cleaning of external, unsecured window glass.

C. Reduction in the amount of fencing, security lighting and anti-vandalism devices required.

D. Reduction in time required for precision mowing of grass. (Campus style building requires much precision mowing in corners and around projections of the complex units. This is both expensive and disturbing to classes).

E. Reduction in costs of installation and maintenance of storm drains, especially drains in open areas surrounded by building units.

F. Reduction of costs of installing and maintaining screens for insect control.

G. Reduction in repair and replacement of window operators.

H. Reduction in damage by humidity and airborne dust to equipment such as clocks, shop tools, projectors, etc.

I. Elimination of blackout curtains and venetian blinds required for audio-visual instruction.

It seemed to these investigators that economy resulting from natural light in the campus type building was largely imaginary because the electric lights operated much if not all the time school was in session.

While it is a capital and not a principal operating economy, it should be pointed out that the compact, climate controlled building can be placed on a smaller site than can the campus and other open type buildings. It occupies less land area and the grounds immediately adjacent can be used for recreation and outdoor instruction without interfering with classroom activities.

If energy rates had been equal and if other factors were disregarded, how would the costs of energy compare for heating, cooling and ventilating these buildings as they were equipped? Only an estimate can be given. Based on rates of 8¢ per therm and 3¢ KWH, these investigators consider this estimate fair:

	1961-62	1962-63
Oak Grove	$1500.00	$1750.00
Pinellas Park	1500.00	2425.00
Tyrone	750.00	1350.00

G. Comparative Quality of Oak Grove and Pinellas Park

An independent estimate of the quality of Oak Grove and of Pinellas Park was based upon the ratings of these two schools by selected members of visiting groups. Selection was made on the basis of criteria designed to identify persons who were knowledgeable about schools in their home communities. While a majority of the visitors were from the southeastern section of the United States, the other principal regions of the United States were represented.

A nine-point rating scale was used. The scoring system was so devised that the school each judge knew best received a rating of 5, the midpoint of the scale, and the two schools involved in this study were then rated relative to that position. To describe the reference school as an "average" or "typical" American school is probably fairly accurate. However, the reference school was more likely to have been somewhat above average, rather than below, because of the selective process which operated to cause some, but not others, to visit these schools.

Three statements on the scale had to do with factors affecting pupils directly. On these statements Pinellas Park was rated as being among the better of the average schools and Oak Grove among the superior schools. Four statements had to do with the facility of use and ease of operation of the building. On these Pinellas Park was rated among the better of the average, or among the definitely better than average schools. On these same points Oak Grove was rated among the superior schools. Four statements had to do with basic qualities of the plant. On these statements Pinellas Park was rated among the average or better than the average. Oak Grove was rated among the superior schools.

From the differences between the distributions of ratings by the judges who visited Oak Grove first and those who visited Pinellas Park first, it was tentatively deduced that five features of Oak Grove caused the judges to revise their standards upward. These features were its ventilation, sound conditions, learning environment, ease of operation and facility of pupil movement. None caused a downward revision.

There appeared to be no features of Pinellas Park which modified the standards of the judges.

H. Comfort

The temperature and humidity conditions within the schools were determined by placing continuous recording instruments in a sample of the classrooms of each school. The instrument readings at 9:30 a.m., 12:00 M., and 2:30 p.m. were used in computing a statistic to represent the daily temperature and the relative humidity. The arithmetic mean of the mid-instrument reading taken at each of these hours was designated the daily mean temperature or humidity. These daily means were computed for each day, with the exception of the relatively few days when instruments were not operative. These daily means were used in reporting the temperature and humidity conditions of the schools and as a basis for placing school days within their proper comfort zones, which subject will be discussed in the following paragraphs.

The comfort of the students in each of the three schools was studied to determine the relationship between the levels of comfort and definable conditions of dry bulb temperature/relative humidity and also to determine the general comfort levels of the student bodies over a full term of operation. The design provided a sampling of climatic conditions and a sampling of students within conditions. Students responded by reporting their comfort with respect to temperature and with respect to humidity separately on eleven point scales. The student responses were so treated that a determination was made of the number and the percentage of students who reported that the conditions were "Comfortable", "Tolerable", and "Uncomfortable" for each 1°/10% of temperature and humidity.

From these reduced data comfort zones were generated for each school. Within each zone, the percentages of students defined as comfortable under each 1°/10% condition of T/H differed from the central tendency of that zone at a confidence level greater than .05. Between zones, the difference between the percentages comfortable was statistically significant at the .05 confidence level. The percentage comfortable within each zone was defined as the comfort index, c, of that zone.

The comfort zones and their respective indices are shown in Figures B, C, D, and E. It should be pointed out that these zones were determined on the basis of temperature and humidity alone and that other factors which influence comfort were not controlled or measured. The variability of these uncontrolled factors seems to have been more restricted in the climate controlled building than in any of the others, permitting the establishment of the more narrowly defined zones in that building.

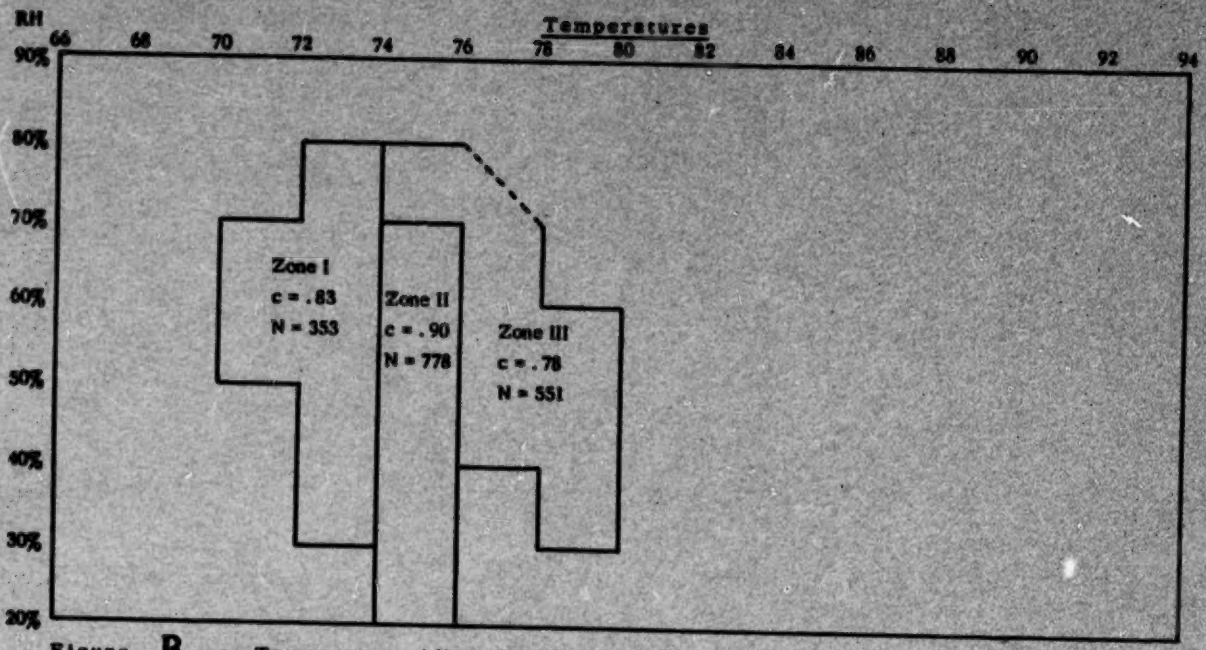


Figure **B** -- Temperature / Humidity Zones and Comfort Indices. Oak Grove, 1961–63.

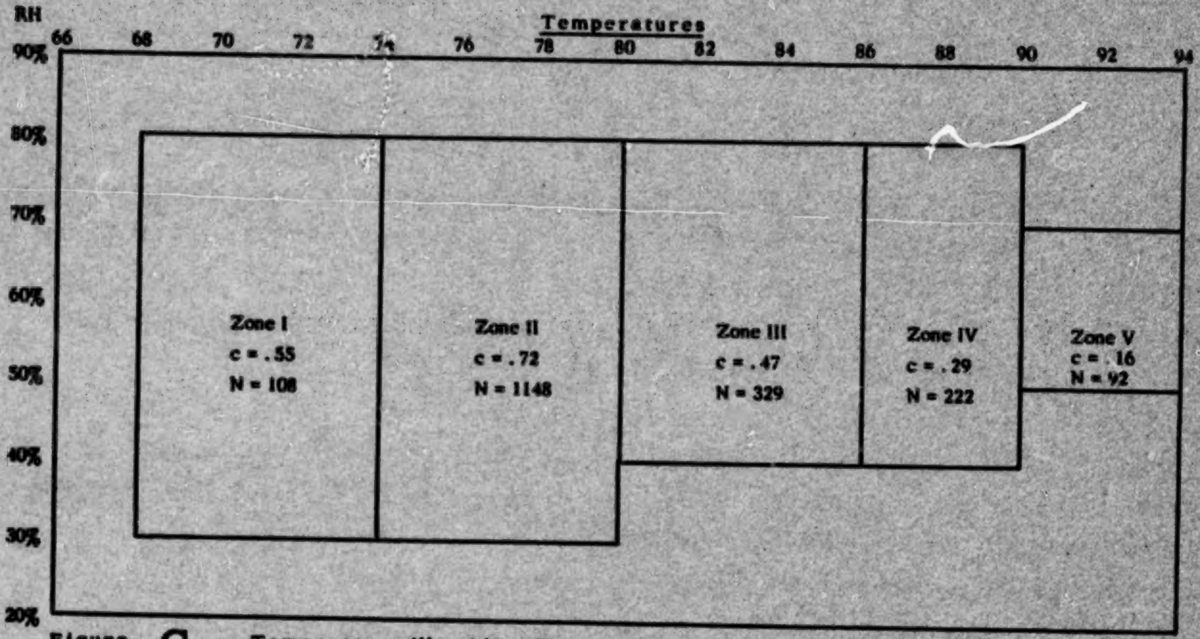


Figure **C** -- Temperature/Humidity Zones and Comfort Indices. Pinellas Park, 1961–63.

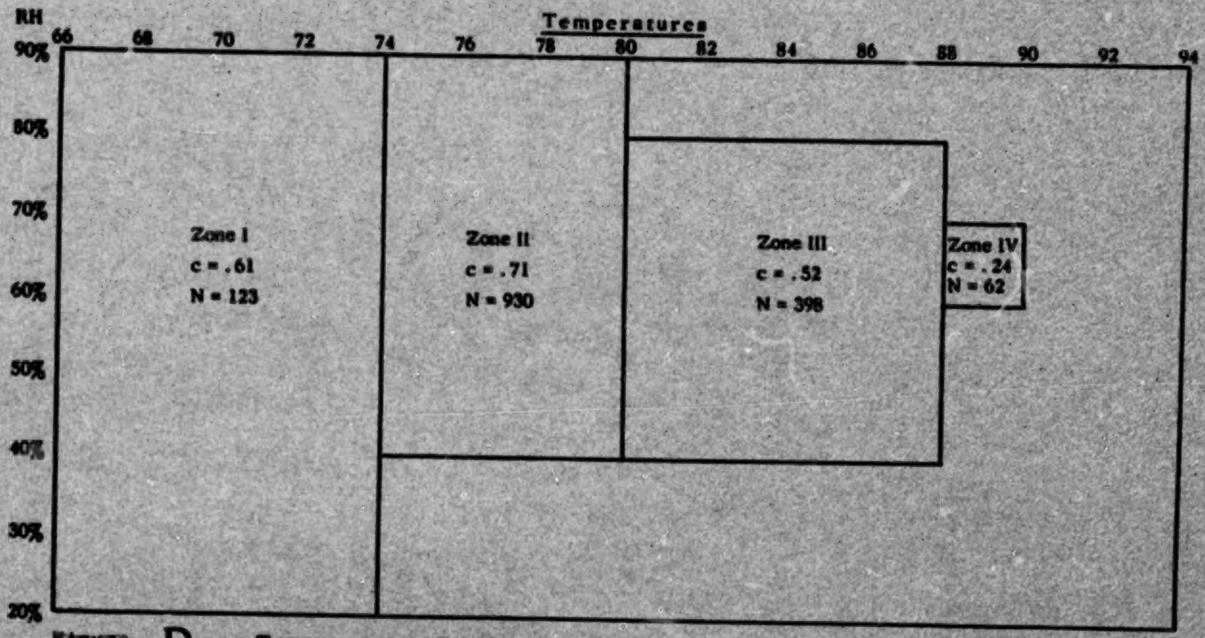


Figure **D** -- Temperature / Humidity Zones and Comfort Indices. Tyrone, 1961–63.

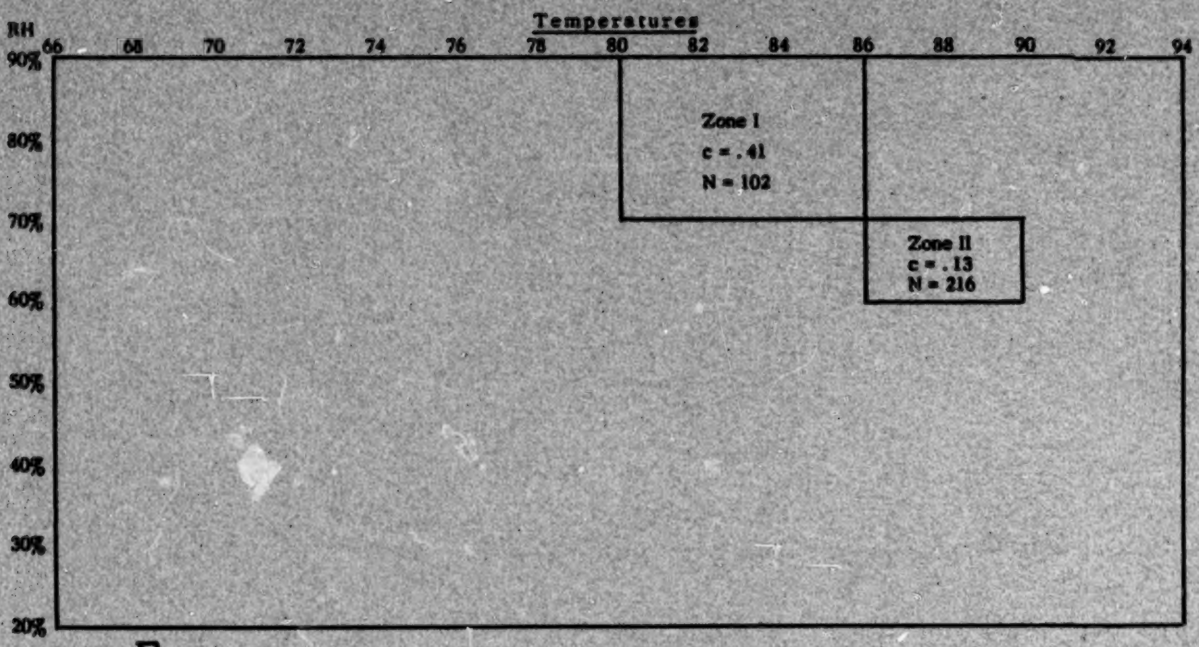


Figure E -- Temperature / Humidity Zones and Comfort Indices. Northeast, 1961– 63.

This suggests that the primary control of temperature in the climate controlled school had correlated benefits in terms of the comfort of students. It should also be mentioned that the comfort zones developed in this study conform quite well to the lines of comfort sensation reported in the ASHRAE GUIDE AND DATA BOOK, 1963.

Annual or term comfort indices were developed for each school. These indices were highly generalized statements expressing the proportion of students who were comfortable under the conditions existing throughout the academic year, or summer term. These comfort indices, designated C, were computed by multiplying each zone index, c, by the number of days whose mean temperature/humidity condition fell within that zone, adding the products and dividing by the total number of days. A few days were lost in this computation because the sampling of conditions in the process of comfort voting did not completely cover all conditions existing throughout the year, and also, because of instrument failure, T/H readings were not available for all days. The comfort indices, C, were subject to these limitations and to the limitations of the daily mean T/H as a completely adequate measure of climatic conditions. The comfort indices, C, for each school for each period studied were:

	1961-62	1962-63	Summer 1961	Summer 1962
Oak Grove	.858	.853	.788	.780
Pinellas Park	.547	.589		
Tyrone	.649	.653		
Northeast			.296	.178

The number of school days during the academic year 1961-62 experiencing mean daily temperatures of 80°F and higher in the more comfortable of two non-climate controlled schools was 57; and during 1962-63 the number was 31. In the less comfortable of the non-climate controlled schools the numbers were 101 for 1961-62 and 53 for 1962-63. For all school days during both summer terms the mean daily temperatures were 80°F, or higher, in the non-climate controlled school. Temperatures in excess of 90°F were found in the rooms of the non-climate controlled schools.

I. Achievement

The comparison of learning in the climate controlled school with that in non-climate controlled schools was an integral part of this study. Confusion exists in this area if the term "learning" is not defined in operational terms or if the measures of learning as defined lack the technical qualities required of good measuring instruments.

These investigators took the position that in this applied study of schools under conditions of normal operation, learning should be operationally defined in terms normally used by educators in assessing the achievement of students. Among these, the most common are teachers' marks and test scores. The latter seemed the most appropriate for this study.

Preliminary investigations indicated that the test scores of students in Oak Grove could be expected to be systematically higher than those of students in Pinellas Park. A second control school was needed in which student test scores could be expected to be as high or higher than those in Oak Grove. For this reason, Tyrone was included in the study.

To obtain curricular validity, the course content in four basic areas, English, mathematics, social studies and science at each grade level was specified in study guides prepared for the schools involved in this project. The instructional content was analyzed by test specialists and a battery was developed which possessed curricular validity in terms of that content. The battery consisted in part of sub-tests drawn from the Metropolitan Achievement Tests, Advanced Battery, 1959 edition, published by Harcourt, Brace and World, Inc. These were supplemented by locally prepared objective tests to obtain adequate coverage of the course content prescribed. The locally prepared test materials were subjected to repeated try-outs in a number of local schools and the final tests were accepted only after it had been established that they possessed discriminating power and reliability and could be administered feasibly as a part of the total battery. The tests were then normed, using students in a representative junior high school of the county. Achievement as measured by the Metropolitan portion of the battery and the Pinellas Supplement portion of the battery were analyzed separately and are so reported.

The criterion measure of achievement utilized in this study was the mean gain in standard test scores between the beginning and the end of each academic year or each summer term. The mean gain was computed for each test in each subject field for each grade within each school. The academic year studies were based upon fourteen tests in each of three grades, making a total of 42 measures of mean gain in each school. From each mean gain of the Oak Grove students, the gain of corresponding students on the same test in each of the other schools was subtracted. The difference in each case was a signed number, positive if the gain of Oak Grove students was larger than that of their counterparts in the school being compared and negative if the Oak Grove gain was smaller. From the relationship of the number of positive to the number of negative differences so determined, the net achievement of Oak Grove relative to each of the other schools was inferred. The same procedure was followed for the summer term studies, but the comparisons were limited to 9 in the summer of 1961 and 16 in the summer of 1962 because these were the total numbers of groups-by-tests available. Each academic year and each summer term was analyzed separately.

This study was based upon schools which were attended by the students, staffed with the teachers, administered and supervised, generally supplied, equipped and operated as they would have been had this study not been in progress. The attendant lack of control over a number of variables that are known or presumed to affect learning outcomes in school imposes limitations upon the results obtained. Specifically, it can only be reported that certain results were obtained. The contribution of any one factor, or of a sub-set of factors, to the results cannot be assessed, nor can statements be made about the probability of the reported relationships holding in other schools or at other times.

Nine comparisons of mean gains were made in the summer of 1961 and 16 in the summer of 1962. The mean gains of Oak Grove exceeded those of Northeast in all comparisons made in the first summer and exceeded in exactly half in the second summer.

The analyses of the summer school data produced the following results:

	Oak Grove	Northeast
	+	-
Summer 1961	9	0
Summer 1962	8	8

The factors which determined who went to summer school were highly variable from year to year and from school to school and quite possibly contributed to the outcomes reported. The investigators suspect that the apparent inconsistency between the two summer terms should be attributed largely to differences inherent in the enrollees as students.

The analyses of the academic year data produced the following results:

	Oak Grove	Pinellas Park	Oak Grove	Tyrone
	+	-	+	-
1961-62	26	16	21	21
1962-63	35	7	34	8

These analyses indicate that each year the gains in achievement, as defined and as measured in this study, were more frequently greater in Oak Grove than in Pinellas Park. Systematic differences in the backgrounds of the students may have contributed to these results. Gains in Oak Grove exceeded those in Tyrone in exactly half of the comparisons made the first year and during the second year, the number of comparisons in which Oak Grove exceeded Tyrone was 34. The number in which it did not exceed was 8. The prior records of Tyrone indicated that its students had been superior to those in Oak Grove in achievement.

Considering the six sets of comparisons reported for the four academic periods, Oak Grove was superior in four, tied with another school in two, and in none did it do less well than the school with which it was compared.

J. Discipline

An analysis of the occurrence of infractions of school disciplinary regulations was made to determine whether the frequency of such was related to the climatic conditions in these schools. The infractions considered were those of which students were sent to the school's disciplinary officer. Those infractions which were handled by teachers within the classrooms were not included.

Early in the analyses, it became apparent that infractions committed by girls should be dropped and the study concentrated upon infractions committed by boys. The pattern of the distribution of days having given infraction rates at Oak Grove was quite similar to that at Tyrone. Pinellas Park differed from either of the other schools in that it tended to have fewer days with lower rates and more days with higher rates than did either of the other schools. A comparison of disciplinary infractions between schools did not appear fruitful because of the evident effect of uncontrolled variables within schools.

It was established that among boys at Pinellas Park there was a significant and inverse relationship between the comfort level of the school and the rate of tardiness and absence without leave. The fact that periods of low comfort levels occurred in the fall and in the spring when out-of-school activities may be very attractive to boys, suggests the need for further investigation to determine more precisely the relationship between discomfort within the school and the tardiness and unauthorized absence of boys.

The investigators think that the relationship between climate, or comfort, and student behavior more probably can be detected within classrooms than it can through the observation of the more serious infractions for which students are sent to the disciplinary officer of the school.

K. Health

The health of students was studied on the basis of data recorded by a registered public health nurse stationed in each school. The nurses were assisted in the clerical work involved. Physicians were not associated with the project, but the nurses based their case reports on the diagnosis of the family physician when such was available.

The analysis of the data indicated that illness in all forms was the cause of 74-87% of absences in all schools over the two year period. The mean monthly absence rate per 100 students attributed to illness in all forms was 3.54 in Oak Grove, 3.68 in Tyrone and 4.79 in Pinellas Park. The difference between Oak Grove and Tyrone was small. Socio-economic factors not present in the other schools may have contributed to the relatively high absence rate in Pinellas Park.

Of the illnesses enumerated in the record form that was developed, five classifications were subjected to detailed study. These included illnesses classified as Upper Respiratory, Communicable Diseases, Skin Diseases, Gastro-Intestinal, and Non-Specific. The analyses showed a high degree of similarity among all schools and no instance of dis-similarity between the climate controlled school and either of the others except that the rates at Pinellas Park were systematically higher than in the other schools. This difference was predictable on the basis of the difference in the socio-economic level of the communities served. The schools experienced illness at epidemic rates to approximately the same extent and the proportions of students ill appeared to increase and to decrease at approximately the same rates. Clinic use within schools appeared to have been more greatly influenced by changes in internal policy than by fluctuations in the health conditions of students.

While it is possible that more refined data would have shown differences, the data employed in this study failed to show any clear relationship between the climate of the school and the health of its students.

L. Concluding Statement

The investigators think that generalizations covering the total study would not be appropriate because this study has been based upon specific schools as operating units and not as samples of a larger universe of schools. The data reported contain many findings favorable to the compact climate controlled school. The investigators found no evidence that the compact climate controlled plant adversely affected the school program, the students or the teachers. The capital costs for constructing the fully climate controlled school was less or approximately the same as those costs for constructing the non-climate controlled school. The operating costs were somewhat higher than those of one non-climate controlled school, but not as high as those of the other.

The investigators purposely have been conservative in their interpretations of the data. They believe that their findings based upon these schools can be more validly applied to specific situations by men who know those situations than generalized by these investigators to all schools in the state or nation.

The study has raised problems of design, of measurement and of analysis which merit the attention of students of these areas. The relationship between climate control and human behavior (comfort, achievement, discipline, and health) involves fundamental considerations worthy of carefully programmed research. It is hoped that this study will contribute to the work of scholars in the several disciplines concerned.

CLIMATE CONTROLLED AND NON-CLIMATE CONTROLLED SCHOOLS:

An Evaluative Study Conducted in Pinellas County, Florida.

FRED STUART, ED. D.
Project Supervisor
Pinellas County Public Schools
Clearwater, Florida

H. A. CURTIS, ED. D.
Research Consultant
Florida State University
Tallahassee, Florida

THE RESEARCH REPORTED HEREIN WAS PERFORMED PURSUANT TO A CONTRACT WITH THE UNITED STATES OFFICE OF EDUCATION, DEPARTMENT OF HEALTH, EDUCATION AND WELFARE;

AND

THIS REPORT CONTAINS THE RESULTS OF COOPERATIVE RESEARCH BETWEEN THE AMERICAN SOCIETY OF HEATING, REFRIGERATING, AND AIR CONDITIONING ENGINEERS, THE PINELLAS COUNTY BOARD OF PUBLIC INSTRUCTION AND THE FLORIDA STATE UNIVERSITY.

COOPERATIVE RESEARCH PROJECT NO. 1067
ASHRAE NO. R. P. 26

Floyd T. Christian, Superintendent
Pinellas County Board of Public Instruction
Clearwater, Florida

1964

INTRODUCTION AND ACKNOWLEDGMENTS

An objective report of research usually omits any account of the chain of circumstances which led up to the investigation and any account of the facilitating activities in which investigators engaged. The authors of this report will sketch these accounts by reporting contributions of the many individuals, industries, agencies and professional associations who participated in this study in the approximate order in which they became involved. In this section we claim our traditional right to speak for ourselves and to communicate informally, using the first person when it suits the occasion.

It is impossible to determine precisely when this study began or to identify one person as the individual who initiated the idea that a study of this kind should be conducted. Responsible educational leaders have been concerned about the possible operation of schools on a twelve-months basis for a number of years. The prospects of conducting instruction during the summer months caused a concern about student comfort and the relationship between comfort and learning. Advances in the basic and applied sciences had enabled a number of industries to develop equipment capable of controlling the interior climate of schools, but they had little or no experience in supplying the demands of the school market, should such develop. The possibility of fully controlling schoolroom climate also offered a means to the solution of problems unrelated to climate as such. Land values in congested metropolitan areas had risen to the point that the use of climate control equipment in very compact school plants might be more economical than purchasing the land necessary for more extended buildings. The noise of street traffic and the high sound levels of jet aircraft were increasingly interfering with instruction in schools in congested urban areas and in those near super highways and civilian and military airfields. If buildings could be climate controlled, they could be sound-proofed. These and other factors had created an interest in the study of climate control applied to schools.

Floyd T. Christian, Superintendent of Public Instruction of Pinellas County, Florida; Thomas D. Bailey, Superintendent of Public Instruction of the State of Florida; and J. M. Osborne, a representative of the American Air Filter Company, Inc., were directly responsible for the initiation of this study. As the plans took shape, Superintendent Christian conferred with the members of the County Board of Public Instruction and with members of his staff; Superintendent Bailey conferred with members of the State Board of Education, with members of his staff and with other educational leaders who were interested in the subject. Mr. Osborne consulted the home office of his company and conferred with responsible members of the numerous industries involved in the manufacture of equipment and the supplying of energy that would be used for the control of climate in schools. There was unanimous agreement that an objective report should be produced in which the costs, comfort and educational outcomes of a climate controlled building were compared with those obtained in a typical non-climate controlled school designed to serve the same number of students. At the time that these three men had succeeded in marshalling the financial, professional and moral support of their respective organizations and the associated interests, there was an exchange of formal memoranda finalizing the arrangements.

Chairman of the Board of Public Instruction, Charles E. Helman and Board Members, William H. Williams, James E. Hendry, Elwyn C. Vevier, Mrs. Marjorie Whitley, Mrs. Mildred Day, and Miss Frances Belcher authorized the construction of the necessary buildings and approved the use of their school system for the study. Mrs. Jane Manson who joined the Board at the expiration of Miss Belcher's term of office also gave her support to the execution of the project.

The full support of the plans and official authorization to make the necessary exceptions to existing school building regulations were granted by the State Board of Education, composed of the following members: Leroy Collins, Governor; R. A. Gray, Secretary of State; Richard W. Ervin, Attorney General; J. Edwin Larson, State Treasurer; and Thomas D. Bailey, Superintendent of Public Instruction.

The firms of Bruce and Parrish, Architects, and Charles L. Colwell respectively designed and supervised the construction of Oak Grove, the climate controlled school, and of Pinellas Park, the non-climate controlled school. Both firms contributed to the plans for the study of the costs of construction and operation of the buildings and continued their support throughout the project. Healy and Lattimer, mechanical engineers, and Henry Wright, Professor and Coordinator, Architectural and Mechanical Engineering, Columbia University, advised with the investigators on technical matters relating to this study.

Carroll McGuffey, Assistant Director for School Plant Administration in the Division of Administration, State Department of Education, contributed the full support of his office and his professional knowledge to the planning of the buildings and the formulation of the study. Robert D. Gates, Coordinator of the National Defense Education Act, State Department of Education, represented the State Superintendent on all matters pertaining to the administration of the research. Philip S. Shaw, Assistant Director of Finance, State Department of Education, rendered invaluable assistance through his handling of the financial aspects of the study.

The project received the personal attention of a large number of widely known individuals and professional organizations. Z. A. Marsh and Jordon Larson were particularly helpful.

During the formative stage of this project, Walter N. Durost, then Director of Educational Services of Pinellas County, developed the design of the research program and prepared the formal request to the Cooperative Research Division of the U. S. Office of Education for its support. The credit for transforming general purposes into researchable problems and developing the program of investigation is most assuredly due Dr. Durost. A contract providing partial support for the research was approved by the Cooperative Research Division of the U. S. Office of Education under Public Law 531 and became effective October 1, 1960. This contract was amended in September, 1963, to provide additional support necessary for the completion of the study.

We, the authors of this report, were asked to assume the responsibility for the execution of the projected research immediately after the negotiation of the basic contract with the U. S. Office of Education. Fred Stuart, a member of the county superintendent's staff, was assigned to the project as its full-time supervisor and Mrs. Victoria Pierce became his secretarial assistant. H. A. Curtis, Head of the Department of Research and Testing, School of Education, Florida State University, joined the project on a part-time basis as research consultant and representative of the State Superintendent's office.

The general supervision of the research program at the local level was the responsibility of a local steering committee, the members of which were: James F. Gollatscheck, chairman, James R. Barnes, Paul D. Bauder, Albert T. Craig, Roy E. Kinnick, Thomas H. Rothchild and Charles O. Smout - all of whom were members of the administrative staff of the County Superintendent of Public Instruction.

We, the authors, assumed our duties in September, 1960. Data collection was programmed to begin with the summer term of 1961.

Pinellas Park was partially occupied in September, 1960. Oak Grove was partially built and scheduled to be occupied February 1, 1961. Its faculty and student body were operating as a school on a half-day basis in another plant. Immediately upon assuming our duties, we attempted to gain a precise understanding of the research as projected in official documents, of the fundamental purposes of the project as conceived by those responsible for it, of the phenomena to be investigated and of the conditions under which the studies would be conducted. The official documents specified or implied that each of the topics reported in subsequent chapters should be investigated. The basic purpose seemed to be that of obtaining in whatever form was appropriate an analytical report of the costs and of the outcomes obtained under conditions of normal school operation in one fully climate controlled building and in one non-climate controlled building and to compare the two. It was suggested that a report couched in terms that could be readily understood by all who were interested in school administration, design, construction, equipment and operation would be of greater value than one loaded with terms specific to any technical field. Through consultation, observation and study, our understanding of the phenomena improved. Our analysis of the basic conditions in the two schools led to the decision to add Tyrone as a second control school for academic year studies and Northeast as the control school for summer studies. We then turned to the task of programming the research activities and "tooling up" for data collection.

The support of industry was unselfish and unstinting. The American Air Filter Company, Inc., made available the services of its engineers and retained architects as needed for consultative services. Mr. Osborne, of that company, continued his personal support of the work. The Minneapolis-Honeywell Regulator Company supplied instruments and materials for recording temperatures and humidities. The Houston Gas Company and its successor, the Florida Gas Transmission Company; the Florida Power Corporation; and the City of Clearwater Gas and Water Division furnished the metering devices requested and the consultant services of their engineers when technical questions arose relating to matters in their respective fields. The Redi-Power Corporation and the Tampa Armature Company furnished consultant services on matters relating to the operation of equipment basic to this study.

The industries that supplied recording instruments and other forms of assistance took the position that the responsibility for data processing and interpretation should rest entirely with the research staff of the project. The School Facilities Council paid for the services of a local science teacher who, on a part-time basis, read, interpreted and recorded physical data. He was directly responsible to the project supervisor.

The Pinellas County Health Department provided the consultive services needed in planning the section of the study dealing with the health of the students and also provided the services of three nurses. Members of the staff of the Florida State Department of Public Health also conferred with us about the study of student health and representatives of the U. S. Department of Public Health conferred with us about airborne particles and communicable diseases.

The instructional supervisors responsible for the program and instruction in English, mathematics, social studies and science gave their leadership to committees of teachers who prepared study guides in each subject field. These guides specified the content of each course in each of the four fields and provided suggestions to the teachers. Test specialists contributed their advice and assistance in making a content analysis of each course and in the development of a test battery that would validly and reliably measure that content. The teachers and students in schools of the county not directly involved in this study participated in the development and scaling of two forms of a locally prepared test battery. This battery was used as a supplement to a standardized battery which had been selected.

Throughout the period of planning and development in 1960-61 and the period of data collection, the principals, staffs, teachers and students cooperated fully with the research staff. All necessary administrative authorizations and adjustments were made by the principals - Nicholas G. Mangin (Oak Grove); James E. Mathews (Pinellas Park); Stanley Moore and Frederick A. Goodrich (Tyrone); and Merle H. Morgan and William Smith (Northeast). The assistant principals, Phil Frederickson and Sam Smith (Oak Grove); William Smith (Pinellas Park); and Ronald R. Hallam (Tyrone) were responsible for discipline and attendance records. James Pratt (Oak Grove); William Nicholson (Pinellas Park); and Joseph Alessi (Tyrone) were responsible for keeping MHU records and changing the daily T/H recorder charts. Health data were collected under the direct supervision of the nurses, Mrs. Mildred Edgar (Oak Grove); Miss Elizabeth Swenson (Pinellas Park and Northeast Summer School) and Mrs. Alexandra Draper (Tyrone). Achievement and comfort data were obtained through the full cooperation of the teachers and students of each of these schools.

The American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc., supported the collection of data during the summer of 1962 and the academic year 1962-63 and provided the consultant services of Albert S. Gates, Jr., Ralph G. Nevins, Leslie P. Greenhill and Martin Mayer. In addition to these consultants, a number of active members of the Society visited the project and offered invaluable

suggestions for the resolution of technical problems. The Society also underwrote the full time services of the research consultant during the major portion of the periods devoted to data analysis and the preparation of the report. It also furnished other subsidies.

In the process of data analysis, Walter Croke and the data processing staff of the Pinellas County schools contributed their expert knowledge and their labor. Mrs. Rosemary Yarr Spencer and Isaiah Moyel, research assistants at the Florida State University, tested alternative modes of data analysis and contributed to the development of many of the techniques employed. The School of Education of that University and the staff of its computing center also made their resources available.

The quality of the final report was greatly enhanced by the expert secretarial services of Mrs. Marjorie Littlejohn and by the editorial services of Miss Lois Arnold.

The authors of this report gratefully acknowledge the contributions of the people, the industries, the governmental agencies and the professional societies and associations named. Many others, including members of the local school and county office staffs, cannot be named because of limitations of space.

The responsibility for the design and methods employed in this study and for the content of this report is solely that of the two principal investigators.

Fred Stuart,
Project Supervisor

H. A. Curtis
Research Consultant

TABLE OF CONTENTS

Introduction and Acknowledgments i

I. Development and Setting 1

- A. History and Development 1
- B. Basic Climatic and Educational Data 4
- C. Summary 6

II. Climatic Conditions 8

- A. General Climatic Conditions 8
- B. Specific Temperature and Humidity Conditions 15

III. Areas, Volumes and Costs of Construction 29

- A. American Standards Association Designations 29
- B. Definitions of American Institute of Architects 39
- C. Local Alternates to AIA Definitions 42
- D. Capital Costs 43
- E. Area, Cubage, and Per-Student Costs 45
- F. Summary on Space and Costs 46

IV. Building Characteristics and Occupancy 47

- A. Plant Layout and Construction 47
- B. Orientation and Areas of Walls and Glass 53
- C. Design Temperature Differences and U Factors 56
- D. Area and Volume Changes During the Project 57
- E. Occupancy of the Schools 58
- F. Summary 60

V. Operating Costs 62

- A. Limitations of Cost Report 62
- B. Rate Structures for Utilities 63
- C. Energy Consuming Equipment 66
- D. Operating Costs 74
- E. Selected Elements in the Operation of Oak Grove 90
- F. Summary and Supplemental Discussion 102

COPIES OF THIS PUBLICATION MAY BE SECURED FOR $2.00 FROM

SUPERVISOR OF CLIMATE CONTROL
PINELLAS COUNTY BOARD OF PUBLIC INSTRUCTION
1895 GULF TO BAY BLVD. CLEARWATER, FLORIDA

VI. Visitor Ratings of Schools 106

A. Methodology 106
B. Analysis of Ratings 112

VII. The Comfort Levels Reported by Students 121

A. Basic Considerations 121
B. Data Collections 123
C. Data Reduction 127
D. Comfort Zones of the Schools 138
E. Annual Comfort Indices of the Schools 142
F. Discussion of the Methodology and Results 150

VIII. The Academic Achievement of Students 157

A. The Setting and Preparation for the Study 157
B. Summer School Studies 168
C. Academic Year Studies 185
D. Significance and Discussion of Results 221
E. Addendum Addressed to Future Investigators 222

IX. Discipline 223

A. Infractions of School Discipline 223
B. Plan for Discipline Study 223
C. Data Gathering 224
D. Discipline Infractions Data 226
E. Summary and Discussion 238

X. Health and Absenteeism 239

A. Methods of Data Collection 240
B. Contributions of Each of Five Classifications of Illness to Absence 246
C. Use of School Clinics 255
D. Summary and Conclusions 260

LIST OF TABLES

Table		Page
I-1	Current Expenditures per Pupil and Number in A. D. A., 1950-1960	7
II-1	Weather Conditions -24 Hour Day-Using All days, July 1, 1961 to June 30, 1962	10
II-2	Weather Conditions-24Hour Day-Using All Days, July 1, 1962 to June 30, 1963	11
II-3	1961-62 Cooling and Heating Degree Days	13
II-4	1962-63 Cooling and Heating Degree Days	13
II-5	Frequency of Occurrence of School Days Having Specified Number of Degree Days of Heating and/or Cooling	14
II-6	Frequency Distribution of T/H, Outside and Inside Readings Oak Grove, Academic Year 1961-62	25
II-7	Frequency Distribution of T/H, Outside and Inside Readings Pinellas Park, Academic Year, 1961-62	25
II-8	Frequency Distribution of T/H, Outside and Inside Reading Tyrone School, Academic Year 1961-62	25
II-9	Frequency Distribution of T/H, Outside and Inside Readings Oak Grove, Academic Year, 1962-63	26
II-10	Frequency Distribution of T/H, Outside and Inside Readings Pinellas Park, Academic Year, 1962-63	26
II-11	Frequency Distribution of T/H, Outside and Inside Readings Tyrone, Academic Year, 1962-63	26
II-12	Frequency Distribution of T/H, Outside and Inside Readings Oak Grove Summer, 1961	28
II-13	Frequency Distribution of T/H, Outside and Inside Readings Northeast Summer, 1961	28
II-14	Frequency Distribution of T/H, Outside and Inside Readings Oak Grove Summer, 1962	28
II-15	Frequency Distribution of T/H, Outside and Inside Readings Northeast Summer, 1962	28
III-1	Gross Areas by ASA Designations	32
III-2	Instruction and Administration Areas by ASA Designations	33
III-3	Service Areas by ASA Designations	34

Table Page

III-4 Circulation & Construction Areas by ASA Designations 35

III-5 Summary of Areas According to American Standards Association Designations 35

III-6 Areas Within Sections of Oak Grove 36

III-7 Areas Within Sections of Pinellas Park 37

III-8 Areas in Addition to those Covered by ASA Designations 38

III-9 Oak Grove Gross Area and Volume by A. I. A. Definitions 40

III-10 Pinellas Park Gross Area and Volume by A. I. A. Definitions 41

III-11 First Alternate Area and Volume Data 42

III-12 Capital Costs of Oak Grove and of Pinellas Park as Comparable Buildings 44

III-13 Costs Divided by Three Alternate Formulas 45

III-14 Total School Plant Costs 46

IV-1 Orientation and Areas of Walls and Glass, 1961-62 54

IV-2 Heating and Cooling Estimates at Oak Grove 56

IV-3 Man-Hours-Use of Schools, 1961-62 59

IV-4 Man-Hours-Use of Schools, 1962-63 59

IV-5 Capacities and Usage of Schools, 1961-62 60

IV-6 Capacities and Usage of Schools, 1962-63 60

V-1 Btu Factor Correction for Natural Gas Delivered after August 1, 1962 65

V-2 Costs of Fuels per MBtu 66

V-3 Costs of Electricity per kwh by School 66

V-4 Fuel Utilization for 1961-62 67

V-5 Capacities and Units of Space-Heating Equipment Supplied by Oil Fired Furnaces 1961-62 68

V-6 Equipment Using Gas During 1961-62 69

V-7 Location and Wattage of Lighting 1961-62 70

Table Page

V-8 Oak Grove Air Handling Equipment 1961-62 71

V-9 Exhaust Equipment Motors 1961-62 72

V-10 Motors in Air Handlers, Unit Heaters and Ventilators 1961-62 72

V-11 Kitchen and Boiler Room Electrical Equipment 1961-62 73

V-12 Home Economics, Shop, and Miscellaneous Electrical Equipment 1961-62 74

V-13 Total Cost Data for Twelve Months Operation 1961-62 76

V-14 Total Cost Data for Twelve Months Operation 1962-63 77

V-15 Total Twelve Months Cost of Operation 1961-62 78

V-16 Total Twelve Months Costs of Operation July 1, 1962 - June 30, 1963 79

V-17 Twelve Months Operational Cost Expressed in Terms of Designated Units 1961-62 81

V-18 Twelve Months Operational Cost Expressed in Terms of Designated Units 1962-63 81

V-19 Energy Cost for Twelve Months July 1, 1961 - June 30, 1962 83

V-20 Energy Cost for Twelve Months July 1, 1962 - June 30, 1963 83

V-21 Units of Energy Used for Twelve Months July 1, 1961 - June 30, 1962 83

V-22 Units of Energy Used for Twelve Months July 1, 1962 - June 30, 1963 83

V-23 MBtu's Consumed in Twelve Months July 1, 1961 - June 30, 1962 84

V-24 MBtu's Consumed in Twelve Months July 1, 1962 - June 30, 1963 84

V-25 Twelve Months Energy Consumption (MBtu's) Expressed in Terms of Designated Units 1961-62 85

V-26 Twelve Months Energy Consumption (MBtu's) Expressed in Terms of Designated Units 1962-63 85

V-27 Energy Costs of Nine Months of Operation of Each of the Three Schools by Academic Years, 1961-62 and 1962-63 86

V-28 Nine Months Energy Cost Expressed in Terms of Designated Units 1961-62 87

V-29 Nine Months Energy Cost Expressed in Terms of Designated Units 1962-63 87

Table Page

V-30 Energy Usage for Specific Purposes and Estimated Cost for Nine Months Period, 9/5/61-6/8/62 88

V-31 Energy Usage for Specific Purposes and Estimated Cost for Nine Months Period, 9/4/62-6/6/63 89

V-32 Weekly Temperature Conditions and Equipment Usage at Oak Grove Nine Months Period - September 5, 1961 to June 8, 1962 92

V-33 Weekly Temperature Conditions and Equipment Usage at Oak Grove Nine Months Period - September 4, 1962 to June 6, 1963 93

V-34 Climate Control School Records from February 1, 1961 through December 31, 1963. Hours of Operation and Gas Consumed, Engine Items Used, Water Treatment and Filters Required 97

VI-1 Oak Grove Ratings - Frequency Distribution of Scaled Values Awarded by Judges Visiting Oak Grove First 114

VI-2 Oak Grove Ratings - Frequency Distribution of Scaled Values Awarded by Judges Visiting Pinellas Park First 114

VI-3 Pinellas Park Ratings - Frequency Distribution of Scaled Values Awarded by Judges Visiting Pinellas Park First 115

VI-4 Pinellas Park Ratings - Frequency Distribution of Scaled Values Awarded by Judges Visiting Oak Grove First 115

VI-5 Medians of the Two Sets of Ratings of Pinellas Park and of Oak Grove and Their Respective Means 116

VI-6 Comparison of Ratings by Order of Visitation 119

VII-1 to 4 Number and Percentages of Students Voting Comfortable, Tolerable and Uncomfortable. Basic Tabulations in Units of 1^o/10%, 1961-62 and 1962-63 combined 130-131

VII-5 Comfort Indices in Units of 2^o/10% (T/RH) and the number of Observations in Each Cell, Oak Grove, 1961-63 133

VII-6 Comfort Indices, Number, and Confidence Levels of Differences between Adjacent Cells. Units of 2^o/20-69% and 2^o/70-79% 134

VII-7 An Illustrative Table Showing the Frequency Distribution of Inside T/H Readings of Oak Grove, 1961-62, Fitted into the Comfort Zones of that School 136

VII-8 Frequency Distribution of T/H, Inside Readings for Three Schools with Comfort Zones Superimposed - Academic year 1961-62 144

VII-9 Frequency Distribution of T/H, Inside Readings for Three Schools with Comfort Zones Superimposed - Academic year 1962-63 145

Table		Page
VII-10	Frequency Distribution of T/H, Inside Readings for Northeast and Oak Grove with Comfort Zones Superimposed - Summers 1961 and 1962	146
VII-11	Comfort Indices for the Academic Year 1961-62	147
VII-12	Comfort Indices for the Academic Year 1962-63	147
VII-13	Comfort Indices for the Summer 1961	148
VII-14	Comfort Indices for the Summer 1962	148
VIII-1	Median School Years Completed by Persons 25 Years Old and Over as Reported by the U. S. Bureau of Census, 1950 and 1960	159
VIII-2	SAT and ITED Standard Score Means and Percentile Ranks of 9th Grade Students in Each of Three Schools	162
VIII-3	Standardization Data for Pinellas Supplementary Tests	164
VIII-4	Annual Comfort Indices, C, of Each School for Each Term	167
VIII-5	Number of Students Included in Study Classified by School, Grade and Subject, Summer of 1961 and 1962	169
VIII-6	Percentage of Teachers Holding Certificates of Specified Ranks - Oak Grove and Northeast, Summer 1961 and 1962	170
VIII-7	Mean Number of Years of Experience of Specified Types - Oak Grove and Northeast, Summer 1961 and 1962	171
VIII-8	Testing Program, Summer 1961	173
VIII-9	Analyses of Mean Scores by School and by Subject Test, Summer 1961	174
VIII-10	Analyses of Mean Scores on Common Examination by School and by Subject Studied, Summer 1961	175
VIII-11	Analyses of Mean Scores of All Students on Common Examination by School and by Grade Level, Summer 1961	176
VIII-12	Testing Program, Summer 1962	179
VIII-13	Analyses of Mean Scores by School and by Subject Test, Summer 1962	180
VIII-14	Analyses of Mean Scores on Metropolitan English Test by Schools and by Grade Levels, Summer 1962	182
VIII-15	Analyses of Mean Scores on Pinellas Supplementary English Test by Schools and by Grade Levels, Summer 1962	182

Table Page

VIII-16 Analyses of Mean Scores on Metropolitan Arithmetic Test by Schools and by Grade Levels, Summer 1962 183

VIII-17 Analyses of Mean Scores on Pinellas Supplementary Arithmetic Test by Schools and by Grade Levels, Summer 1962 183

VIII-18 Percentage of Teachers in Each School Holding Certificates of Specified Rank and Permit to Teach Out of Field Academic Year 1961-62 185

VIII-19 Median Chronological Age and Mean Years of Experience of the Faculties, Academic Year 1961-62 186

VIII-20 Number of Students Transferred, Academic Year 1961-62 187

VIII-21 Number of Students Included in Study of Achievement, Classified by School and Grade Within School, Academic Year 1961-62 190

VIII-22 Pre-Test, Post-Test and Standard Score Differences on Each Test. Reported by Schools, Academic Year 1961-62 192

VIII-23 Mean Standard Score Gains by Schools and Differences Between Mean Gain of Oak Grove and Each Other School on Each Test, Academic Year 1961-62 193

VIII-24 Pre-Test, Post-Test and Standard Score Differences on Each Test. Grade Seven Reported by Schools, Academic Year 1961-62 195

VIII-25 Pre-Test, Post-Test and Standard Score Differences on Each Test. Grade Eight, Reported by Schools, Academic Year 1961-62 196

VIII-26 Pre-Test, Post-Test and Standard Score Differences on Each Test. Grade Nine, Reported by Schools, Academic Year 1961 197

VIII-27 Discrimination of Grade Levels of Pre-Tests and Post-Tests in Each of the Three Schools, Academic Year 1961-62 198

VIII-28 Number of Tests on Which Differences Between Pre-Test and Post-Test Mean Scores Were Positive and Negative, Classified by School and Grade, Academic Year 1961-62 199

VIII-29 Mean Seventh Grade Standard Score Gains by Schools and Differences Between Mean Gain of Oak Grove and Each Other School on Each Test, Academic Year 1961-62 200

VIII-30 Mean Eighth Grade Standard Score Gains by Schools and Differences Between Mean Gain of Oak Grove and Each Other School on Each Test, Academic Year 1961-62 201

VIII-31 Mean Ninth Grade Standard Score Gains by Schools and Differences Between Mean Gain of Oak Grove and Each Other School on Each Test, Academic Year 1961-62 202

Table		Page
VIII-32	Summary of Frequencies of Signed Differences Between Oak Grove and Each of Two Other Schools in Tested Achievement, Academic Year 1961-62	203
VIII-33	Percentage of Teachers in Each School Holding Certificates of Specified Rank and Permit to Teach Out of Field, Academic Year 1962-63	205
VIII-34	Mean Years of Teaching Experience of the Faculties, Academic Year 1962-63	205
VIII-35	Number of Students Transferred. Academic Year 1962-63	205
VIII-36	Number of Students Included in Study of Achievement, Classified by School and Grade Within School, Academic Year 1962-63	207
VIII-37	Pre-Test, Post-Test and Standard Scored Differences on Each Test. Reported by Schools, Academic Year 1962-63	209
VIII-38	Mean Standard Score Gains by Schools and Differences Between Mean Gain of Oak Grove and Each Other School on Each Test, Academic Year 1962-63	210
VIII-39	Pre-Test, Post-Test and Standard Score Differences on Each Test. Grade Seven, Reported by Schools, Academic Year 1962-63	211
VIII-40	Pre-Test, Post-Test and Standard Score Differences on Each Test. Grade Eight, Reported by Schools, Academic Year 1962-63	212
VIII-41	Pre-Test, Post-Test and Standard Score Differences on Each Test. Grade Nine, Reported by Schools, Academic Year 1962-63	213
VIII-42	Mean Seventh Grade Standard Score Gains by Schools and Differences Between Mean Gains of Oak Grove and Each Other School on Each Test, Academic Year 1962-63	214
VIII-43	Mean Eighth Grade Standard Score Gains by Schools and Differences Between Mean Gain of Oak Grove and Each Other School on Each Test, Academic Year 1962-63	215
VIII-44	Mean Ninth Grade Standard Score Gains and Differences Between Mean Gain of Oak Grove and Each Other School on Each Test, Academic Year 1962-63	216
VIII-45	Discrimination of Grade Levels of Pre-Tests and Post-Tests in Each of the Three Schools, Academic Year 1962-63	217
VIII-46	Number of Tests on Which Differences Between Pre-Test and Post-Test Mean Scores Were Positive and Negative, Classified by School and Grade, Academic Year 1962-63	218

Table Page

VIII-47 Summary of Frequencies of Signed Differences Between Oak Grove and Each of the Two Other Schools in Tested Achievement, 1961-62 and 1962-63 220

IX-1 Infractions of School Discipline Classified by School, Grade and by Sex, 1961-62 227

IX-2 Mean Daily Infractions by Week and Stanine Level of Each; Weekly Comfort Indices and Dichotomous Classification of Each 231

IX-3 Distribution of Infractions by Comfort Levels Oak Grove, 1961-62 232

IX-4 Distribution of Infractions by Comfort Levels Tyrone, 1961-62 232

IX-5 Distribution of Infractions by Comfort Levels Pinellas Park, 1961-62 233

IX-6 Distribution of Two Levels of Infractions by Two Levels of Comfort Pinellas Park, 1961-62 235

IX-7 Distribution of Type I Infractions and School Days by Two Levels of Comfort Pinellas Park, 1961-62 237

IX-8 Distribution of Weekly Mean Infractions of Type II and Levels of Comfort Pinellas Park, 1961-62 237

X-1 Means of Three Groups of Monthly Absences per 100 Students in ADM Oak Grove, Pinellas Park and Tyrone, 1961-62 and 1962-63 247

X-2 Number of Students Absent Per 100 in ADM for each of the School Months of the Academic Year 1961-62 249

X-3 Monthly Rates of Absence per 100 Students in Average Daily Membership for All Reasons and for Specified Classifications of Illnesses 250

LIST OF FIGURES

Figure | Page

I-1 Architectural Rendering of Oak Grove and Pinellas Park School Plants 3

II-1 Inside and Outside Temperatures and Humidities 1961-62 - Oak Grove 18-19

II-2 Inside and Outside Temperatures and Humidities 1961-62 - Pinellas Park 20-21

II-3 Inside and Outside Temperatures and Humidities 1961-62 - Tyrone 22-23

IV-1 Plant Layout of Each School 48

IV-2 Plan Views of Classroom Sections of Each School 49

IV-3 Typical Classroom Wall Sections 52

VI-1 Visitors Rating Instrument 109-110-111

VI-2 Relative Scale Positions of Pinellas Park, of Oak Grove, and of Raters' Typical School in Terms of Each Scale Statement 117

VII-1 Scales Utilized for the Reporting of Individual Student Comfort 125

VII-2 Schematic Basis for the Three-way Classification of Student Comfort Votes 128

VII-3 Temperature/Humidity Zones and Comfort Indices, Oak Grove, 1961-63 135

VII-4 Temperature/Humidity Zones and Comfort Indices, Oak Grove, 1961-63 139

VII-5 Temperature/Humidity Zones and Comfort Indices, Pinellas Park, 1961-63 139

VII-6 Temperature/Humidity Zones and Comfort Indices, Tyrone, 1961-63 139

VII-7 Temperature/Humidity Zones and Comfort Indices, Northeast, 1961-63 141

VII-8 Graphical Representation of the Relationships Between the Mid-Temperature and Comfort Indices of Zones 148

VII-9 Comfort Indices of Schools by Academic Terms of the Total Study 149

VII-10 Oak Grove Comfort Zones and Lines of Comfort Sensations 152

VII-11 Pinellas Park Comfort Zones and Lines of Comfort Sensations 153

VII-12 Tyrone Comfort Zones and Lines of Comfort Sensations 154

VIII-1 Weekly Comfort Indices of Oak Grove and of Northeast, Summer 1961 172

Figure Page

VIII-2 Weekly Comfort Indices of Oak Grove and of Northeast, Summer 1962 178

VIII-3 Weekly Comfort Indices of the Three Schools, Academic Year 1961-62 189

VIII-4 Weekly Comfort Indices of the Three Schools, Academic Year 1962-63 206

IX-1 Daily Record of Discipline Infractions 225

IX-2 Frequency Distribution of Daily Infractions Per Hundred Boys 1961-62 229

X-1 Weekly Report Form Showing Classifications of Illnesses and Other Absences 241

X-2 Readmission Form Providing for Parent Report of Student's Absence 242

X-3 Chronological Record Sheet Listing Student Use of Clinic 243

X-4 Individual Student Clinic Record 244

X-5 Record of Students Suspected of Chronic Upper Respiratory or Allergy-Related Illness 245

X-6 Monthly Absence Rates of Each School for Each Year, 1961-62 and 1962-63 251

X-7 Monthly Rates of Absence Attributed to Upper Respiratory Illnesses, 1961-62 and 1962-63 253

X-8 Monthly Rates of Absence Attributed to Communicable Diseases 1961-62 254

X-9 Monthly Rates of Absence Attributed to Communicable Diseases 1962-63 254

X-10 Monthly Rates of Absence Attributed to Skin Diseases, 1961-62 254

X-11 Monthly Rates of Absence Attributed to Skin Diseases, 1962-63 254

X-12 Monthly Rates of Absence Attributed to Gastro-Intestinal Illnesses, 1961-62 256

X-13 Monthly Rates of Absence Attributed to Gastro-Intestinal Illnesses, 1962-63 256

X-14 Monthly Rates of Absence Attributed to Non-Specific Illnesses, 1961-62 257

X-15 Monthly Rates of Absence Attributed to Non-Specific Illnesses, 1962-63 257

X-16 Monthly Rates of Clinic Usage, 1961-62 and 1962-63 259

CHAPTER I

DEVELOPMENT AND SETTING

The basic purpose of this total study was to ascertain and to report similarities and differences between a fully climate controlled school and certain non-climate controlled schools in the same school system. Under study would be costs of construction and operation; climate; comfort, achievement, discipline, health, and attendance of students; and evaluations by professionally knowledgeable visitors. The schools involved are units of the Pinellas County, Florida, public school system. All schools in this study enrolled seventh, eighth and ninth grade students living in the respective attendance areas.

A. History and Development

In retrospect, it is difficult to fix the beginning of this study. Early in 1959, or even before, the Superintendent of Public Instruction of Pinellas County, the Florida State Superintendent of Public Instruction and members of his staff,and representatives of certain industries interested in the construction and the equipment of climate controlled schools were exploring the idea of designing and constructing two schools, one to be climate controlled and one not, to be used for the study of costs and other aspects of air conditioning in schools. The idea was explored informally with members of the State Board of Education and other educational leaders of the state, with the members of the County Board of Public Instruction and local educational leaders and with the "home offices" of interested industries. There was a general endorsement of the concept and a general agreement that the project would require and merit the cooperation of the state, of the county school system, and of a number of industries.

During the months of July and August, 1959, the initial formal interchanges of memoranda took place. A responsible representative of a manufacturer of heating, ventilating and air conditioning equipment confirmed his conversations with the Pinellas County school authorities and advanced the proposal that his company would furnish technical consultants. Within the week of the receipt of this proposal, the county superintendent received a memorandum from the office of the state superintendent confirming the interest of state officials and stipulating that the proposed project would require formal action by the State Board of Education. The county superintendent responded immediately by filing a formal request for the approval of the research project, which he outlined, and by transmitting the offer of the industry to furnish technical consultants. These materials were transmitted to the State

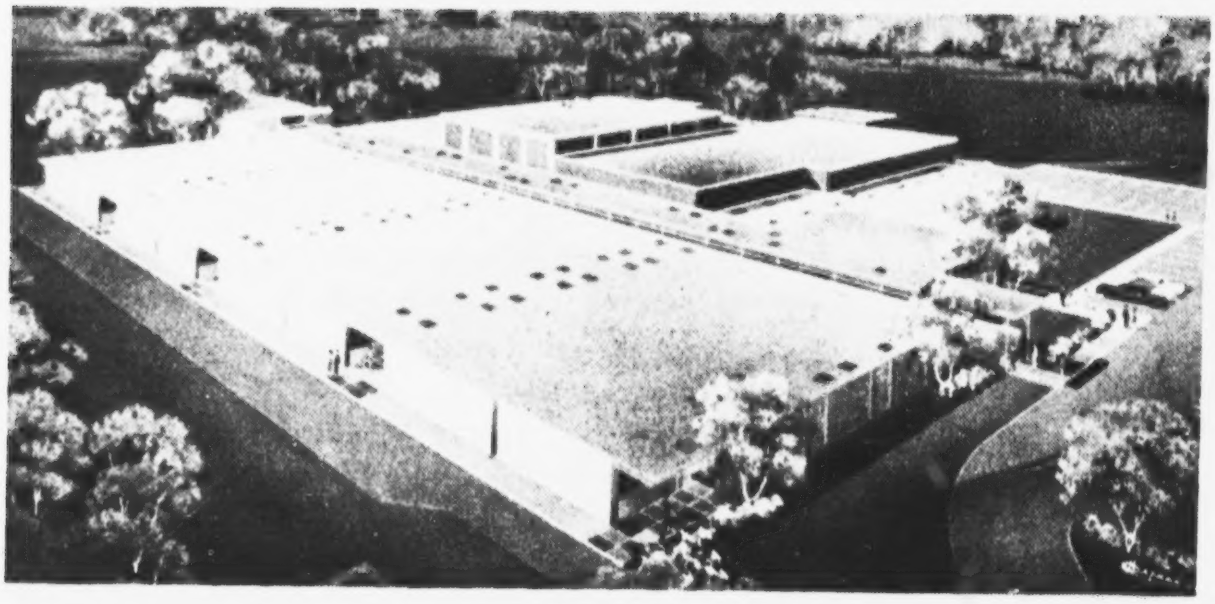
Board of Education about mid-August, together with the request that exceptions be granted to certain regulations pertaining to the lighting and ventilation of school buildings and to the expenditure of state funds for air conditioning. Favorable action was taken.

Two schools were projected. They were to be two comparable physical plants designed to serve approximately the same enrollment. The control school was to be of rather typical Florida design and construction. The experimental school was to be completely climate controlled and designed for the efficient utilization of the heating and cooling equipment and to take advantage of the possibilities such equipment offered in school operation. The location of the two schools within the county was determined by the immediate need of the county for schools in certain areas. It was originally planned that the climate controlled school would be built on the Pinellas Park site and the non-climate controlled school on the Oak Grove site, but the plans were reversed because the population pressure in Pinellas Park required relief at the earliest possible date and the non-climate controlled building could be designed and constructed more expeditiously than could the experimental school.

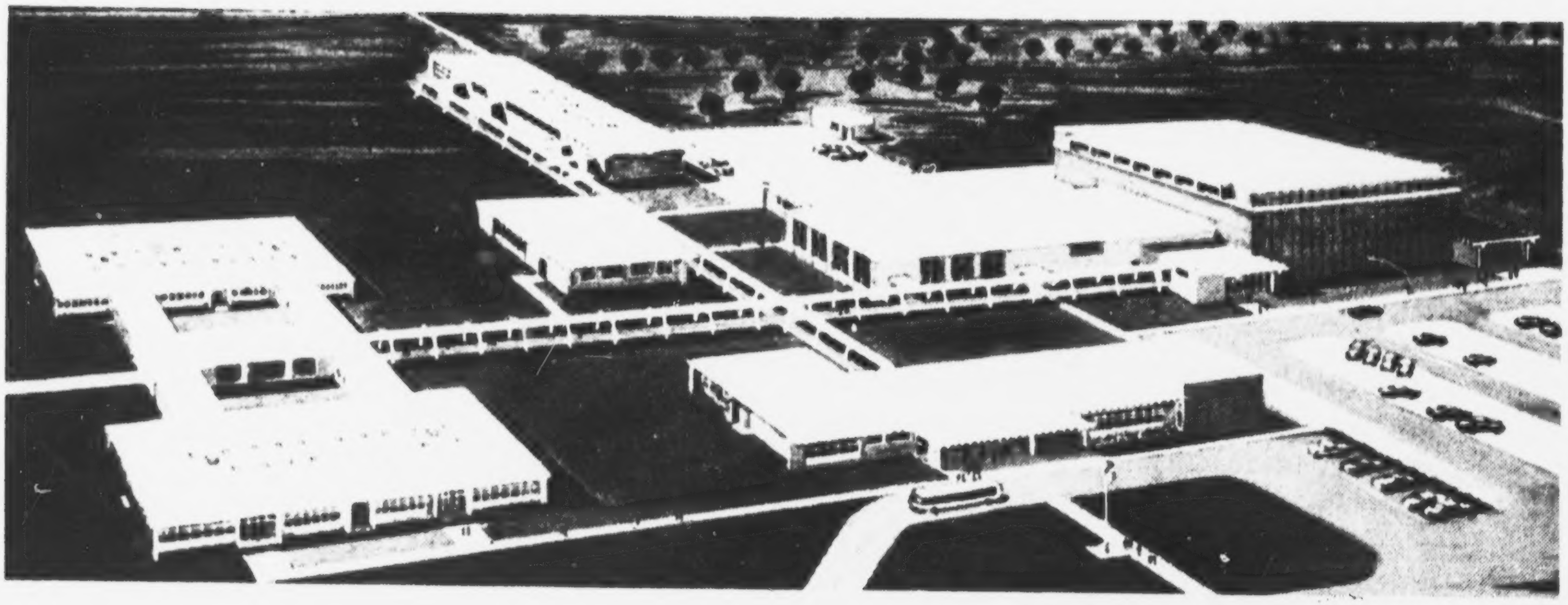
A commission was awarded to one firm of architects to design the non-climate controlled school and to another firm to design the climate controlled school. Each was appraised of the enrollment for which the buildings were to be designed and given the same approximate budget within which to operate. After the usual processes of review and revision, the plans were approved and construction contracts awarded to one construction firm for one building and to another for the second. The architectural rendering of the two plants is shown in Figure I-1. Pinellas Park, the non-climate controlled school, was partially completed and occupied for school purposes in September, 1960, and Oak Grove in February, 1961. Additions were made to both after their initial occupancy.

Plans for research were developed concurrently with the development of plans for, and construction of, the buildings. Basically, the research was to supply data by which costs of construction and of operation and the educational outcomes - student behavior and student health - in the two types of plants could be evaluated. It was implied that the evaluations were to be in terms that would be useful to those responsible for administrative decisions and policy formations in matters having to do with school construction and operation; to those responsible for setting standards for school building design, construction and equipment; and to those industries, architects, and engineers concerned with this field.

The planning of the research work was directed by Dr. Walter N. Durost who was Director of Educational Services of Pinellas County at the time. Under his direction a proposal was formulated for transmittal to the



OAK GROVE JUNIOR HIGH SCHOOL



PINELLAS PARK JUNIOR HIGH SCHOOL

Figure I-1. -- Architectural Rendering of Oak Grove and Pinellas Park School Plants

Cooperative Research Division of the U. S. Office of Education. It was approved as presented and later supplemented by re-negotiations. The resources of the project were supplemented by grants from the School Facilities Council and by grants and consultant services by the American Society of Heating, Refrigerating and Air Conditioning Engineers; by personnel and consultant services supplied by the Pinellas County Department of Public Health; by consultant services supplied by the Florida State Department of Public Health and by the U. S. Department of Public Health; and by instruments, equipment and consultant services supplied by a number of industries. The original plans covered the collection of data in two schools during the summer of 1961 and the academic year 1961-62. The study was broadened by including Tyrone, a second non-climate controlled junior high school, and extended to include the summer of 1962 and the academic year 1962-63. Due to the fact that it did not prove administratively feasible to conduct summer schools at either Pinellas Park or Tyrone, Northeast High School was used as the control school for both summer studies.

B. Basic Climatic and Educational Data

Pinellas County occupies a peninsula between the Gulf of Mexico and Tampa Bay, about midway on Florida's west coast. It is centered about latitude 27° 55' North and longitude 82° 22' West. Its general elevation is 10 to 20 feet above sea level. Its annual rainfall is about 50 inches, 30 of which fall during the four summer months. Night ground fogs occur frequently during the cool winter season. The monthly mean temperatures normally range about 20° from a mean of 61.5° in January to 82° in August. A few light freezes normally occur, but the number and severity fluctuate from year to year.

Because of its climate, the attractiveness of its beaches and the appeal of its water sports, the county is host to many tourists throughout the entire year. The tourist accommodations are located principally along the beaches and tourist children enroll in schools near their temporary homes. The "inland" communities are the homes of the permanent residents or of the people who move to the area for prolonged periods of residence and usually for employment, as well. Schools in these communities experience no significant influx of temporary students. The schools participating in this study were situated in residential areas that were not greatly affected by the seasonal visits of tourists.

Socio-economic data were not collected in this study, but the general cultural conditions may be inferred from U. S. census data. The population of the county was 374,665 in 1960. Of this population approximately 325,000 lived in the urban area of St. Petersburg, including the 11,000 in Pinellas Park, and 35,000 lived in the urban area of Clearwater. The increase in urban St. Petersburg amounted to 184%; in urban Clearwater 122%; and in the city of Pinellas Park 271%.

The communities were made up predominately of single family dwelling units which were owner occupied. In Pinellas Park 96% of the population lived in single family units, 86.6% of which were owner occupied. The median value of the owner occupied units was $10,300; the median size was 4.3 rooms; and 11.9% of the people lived in homes having more than one person per room. In Clearwater, 79.5% of the population lived in single family units, 67.4% of which were owner occupied. The median value of the owner occupied units was $14,100; the median size 4.5 rooms; and 7.3% of the people lived in homes having more than one person per room. In St. Petersburg 78.7% of the population lived in single family units, 72.3% of which were owner occupied. The median value of owner occupied units was $12,000; the median size 4.5 rooms; and 5.9% of the population lived in homes having more than one person per room.

The principal classifications of employment in the county were service occupations, manufacturing and construction. The manufacturing was principally in the fields of light industry. As an approximation, seven people were employed in service occupations for each person employed in construction or in manufacturing.

The median number of school years completed by all persons 25 years old and over in the State of Florida in 1960 was 10.9 years. The comparable number for Pinellas County was 11.1 years. The median number for all persons was not reported for municipalities but was reported for males and females separately. These data indicate the educational level of adult males and females in St. Petersburg was 10.6 and 11.3 years, respectively. For Clearwater the data indicate 11.5 years and 12.0 years for males and for females. For Pinellas Park, the data were 10.2 and 10.4 years.

The data indicate that Pinellas Park is a community which has grown rapidly during the ten years preceding 1960. Its homes tended to be smaller and less expensive than those of St. Petersburg and Clearwater. Also, a larger percentage of the homes were owner occupied and a larger percentage of the people lived in homes in which the number of people exceeded the number of rooms. The number of school years completed by males and by females was lower in Pinellas Park than in either of the other two areas cited. The school at Pinellas Park enrolled junior high school students from this municipality and from outlying areas whose socio-economic level was no higher.

Oak Grove served a relatively new residential area of Clearwater in which the size and value of the homes were definitely greater than those of Clearwater as a whole. The population density per dwelling was probably less than the average for the city. The educational attainment of adults in the school area was equal to, or greater than, that of the total city.

Tyrone served a community in St. Petersburg that had been established approximately six years before those housing developments served by Oak Grove. Its homes, property values, and the cultural level of the adults were superior to those of St. Petersburg in general. The socio-economic levels of the Tyrone and the Oak Grove communities may be considered equal and superior to that of Pinellas Park.

The County Board of Public Instruction administers all public schools in the county and employs a county superintendent as its administrative officer. The county administration has been quite stable over the years. The incumbent superintendent was in office as the elected superintendent from 1948 to 1957 and was appointed by the Board of Public Instruction as superintendent when the office became appointive. Individual membership on the Board of Public Instruction has shifted through the years, but continuity of educational policies has been an important characteristic of the system. These facts suggest that the community has confidence in the administrative leadership of its schools and suggest that the people generally may be expected to regard their schools favorably.

The per capita expenditure for education is commonly considered one index of the general quality of schools. The data reported in Table I-1 indicate that, in Pinellas County, during the decade July 1, 1950-June 30, 1960, the annual current expenditure per student in average daily attendance, grades kindergarten through junior college, ranged from \$188.65 to \$316.54. For nine of the ten years the county expenditures exceeded the average for the state by an amount ranging from 2.0% to 7.3%. The current expenditure for the remaining year, 1956-57, amounted to 99.9% of the state average. Capital outlay for new school plants and capital equipment was in addition to the expenditures reported. Since the county gained approximately 32,000 students in average daily attendance, a gain of 153% over the ten year period, capital outlay was a large item in total educational cost.

C. Summary

It has been the purpose of this chapter to report the background and development of this study and to supply general information about the climate and about the socio-economic status of the communities involved and to supply certain pertinent facts about the school system in which the study was conducted. Such information should help the reader gain an understanding of the basic purposes of the study and should assist him in understanding the climatic, socio-economic, and educational setting in which the research was conducted.

Each of the following chapters reports a specific phase of the total study. In a number of these chapters, selected aspects of the general information will be expanded to furnish the detailed information necessary to interpret the data reported.

Table I-1. -- Current Expenditures per Pupil and Number in A. D. A., 1950-1960*

	School Year									
	1950-51	1951-52	1952-53	1953-54	1954-55	1955-56	1956-57	1957-58	1958-59	1959-60
State of Florida	179.82	194.40	201.56	217.36	226.21	242.69	247.20	291.78	294.16	299.78
Pinellas County	188.65	208.60	211.95	227.58	235.90	248.55	246.98	297.69	302.54	316.54
Pinellas Expenditure Expressed as % of State	104.9	107.3	105.2	104.7	104.3	102.4	99.9	102.0	102.8	105.6
Number Pupils in ADA	20,805	21,814	24,119	26,488	29,324	31,635	36,291	41,354	47,586	52,624

*Thomas D. Bailey, Biennial Report, Superintendent of Public Instruction, State of Florida. Tallahassee, Florida. 1953; 1955; 1957; 1959; and 1961.

CHAPTER II

CLIMATIC CONDITIONS

A. General Climatic Conditions

The general weather conditions of this area are adequately described by the following excerpt from The United States Department of Commerce Weather Bulletins of Tampa International Airport, located within a 20-mile radius of the research project being reported.

> An outstanding feature of the climate of this area is the summer thunderstorm season. On the average there are 85 days with thundershowers occurring mostly in the late afternoons of June, July, August, and September. This results in a sudden drop in temperature -- from about 90° to 70°. Between a dry spring and a dry fall, some 30 inches of rain (about 60 percent of the annual precipitation) fall during the four summer months.
>
> Because of the flat terrain, night ground fogs occur frequently during the cool weather season. Temperature throughout the year is modified by the Gulf of Mexico and the bays. The monthly mean temperatures range about 20° from a mean of 61.5° in January to 82° in August. Freezes occur only a few days during the year.

Continuous recordings of outside temperature and humidity were obtained at the three schools and were used for other parts of the total project. The graphs constructed from these school records indicate that there are differences among the Oak Grove, Pinellas Park, Tyrone, and Tampa Weather Bureau recordings. When there are differences, it appears that the Tampa Weather Bureau is a degree or two higher at noon and the relative humidity is five to ten percent lower than school records. These differences are certainly acceptable in light of the accuracy of the recording devices themselves. For the purpose of this section of the report, the reader can assume that all data presented are within a microclimate and, therefore, are compatible. Weather Bureau records are based on those of the Tampa station at the International Airport, which has an elevation of 19 feet and is at latitude 27° 58' North and longitude 82° 32' West. All recordings reported in Tables II-1-5 are based upon Weather Bureau data. Temperatures are given in degrees Fahrenheit, Dry Bulb. Precipitation is in inches. Wind movement is in miles per hour. Monthly heating degree day totals are the sums of the negative departures of average daily temperature from 65° Fahrenheit.

The data in the following two tables entitled "Specific Weather Conditions" are for full years as indicated, whereas in some cases other data have reported only those days the schools were open for teachers and students. An example that definitely points up the need for considering the difference in school-occupied days and the total days of the month can be seen in the line for December, 1961. The first half of December -- when school was in session -- was very mild and without heating days, whereas the last half of the month was vacation and all these days were high heating degree days.

The headings on the two Tables II-1 and II-2 range from A through N and descriptions of the headings are given at the bottom of the tables. It is significant to note that in 1961-62 temperatures averaged a degree higher than the 30-year average. The number of days during that year having temperatures higher than 90° was eight greater than the 30 year average. The fact that the winter of 1961-62 was very mild, having 162 fewer heating degree days than the 30 year average, had considerable influence upon operating costs. Of even greater significance is the fact that some of the coldest days were in periods of the year during which school was not in session.

The 1962-63 year was a much more severe winter for this area. The yearly average daily minimum and the minimum temperatures of days were both below the 30-year average. Of significance is the total year heating degree days -- there being 820 in 1962-63 in contrast to 512 in 1961-62. The 30-year average was 674. The 1962-63 heating season extended from October through April. The more extended period of cool weather contributed to the reduction in the number of cooling degree days in 1962-63, there being 358 fewer than in 1961-62.

1. Heating and Cooling Degree Days

The definition of heating degree days conforms with that presented in the ASHRAE Guide. For any one day, when the mean temperature is less than 65° Fahrenheit, there exist as many degree days as there are degrees difference between the mean temperature for the day and 65° Fahrenheit. For this purpose the Tampa Weather Bureau data were used because samples of the project's weather data revealed good agreement with this source.

Table II-1. -- Weather Conditions-24 Hour Day-Using All Days, July 1, 1961 to June 30, 1962

Month	A	B	C	D	E	F	G	H	I	J	K	L	M	N
July	91. 3	74. 4	82. 9	96	71	26	0	0	872	7. 69	85	58	9. 2	58
August	90. 9	74. 4	82. 7	97	71	24	0	0	848	6. 22	90	61	9. 6	57
September	91. 1	72. 5	81. 8	96	67	21	0	0	720	2. 43	91	55	10. 0	57
October	84. 8	64. 0	74. 4	90	50	2	5	0	408	. 25	85	55	12. 5	77
November	80. 4	59. 1	69. 8	90	45	1	15	60	258	. 94	87	55	10. 8	67
December	74. 2	54. 2	64. 2	85	33	0	137	163	172	3. 80	81	53	11. 3	73
January	70. 9	50. 1	60. 5	83	29	0	175	201	92	1. 40	88	61	11. 5	67
February	76. 7	56. 8	66. 8	87	42	0	55	148	178	1. 46	89	59	10. 1	79
March	73. 0	54. 5	63. 8	84	39	0	106	102	158	4. 26	85	53	12. 8	63
April	79. 9	58. 9	69. 4	89	43	0	19	0	252	1. 43	80	46	8. 4	72
May	89. 2	66. 6	77. 9	95	59	14	0	0	595	2. 76	90	49	10. 6	68
June	87. 5	71. 7	79. 6	93	66	5	0	0	688	6. 34	90	65	8. 9	58
Year Average or Total	82. 5	63. 1	72. 8	-	-	93	512	674	-	38. 98	87	56	10. 5	66
30-Year Average	81. 2	63. 3	72. 3	-	-	85	674	-	-	49. 94	88	57	8. 6	66

Key to columns -

A = temperature averages-daily maximum F^{o}
B = temperature averages-daily minimum F^{o}
C = temperature averages-monthly average F^{o}
D = temperature extremes-highest F^{o}
E = temperature extremes-lowest F^{o}
F = temperature-number of days 90^{o} and above, F^{o}
G = heating degree days
H = average heating degree days for 30-year period
I = cooling degree days (based on formula given)
J = total precipitation (inches)
K = relative humidity at 7:00 a. m. (percentage)
L = relative humidity at 1:00 p. m. (percentage)
M = average hourly wind speed (MPH)
N = percentage of possible sunlight

Table II-2. -- Weather Conditions-24 Hour Day-Using All Days, July 1, 1962 to June 30, 1963.

Month	A	B	C	D	E	F	G	H	I	J	K	L	M	N
July	90.1	75.9	83.0	94	72	23	0	0	885	2.31	85	62	9.3	61
August	89.9	73.9	81.9	95	71	18	0	0	817	10.14	91	66	8.4	54
September	87.4	72.0	79.7	94	62	10	0	0	716	7.57	90	64	9.4	59
October	84.7	64.8	74.8	91	51	8	2	0	429	1.28	87	56	10.8	80
November	72.1	52.9	62.5	80	37	0	98	60	95	2.21	87	61	12.0	62
December	68.3	48.1	58.2	80	18	0	240	163	58	0.46	84	53	10.8	62
January	69.1	48.0	58.6	79	35	0	212	201	49	2.25	86	60	12.2	60
February	65.9	47.6	56.8	79	37	0	229	148	37	7.95	88	67	13.1	59
March	78.5	58.3	68.4	87	43	0	37	102	230	2.31	90	55	13.0	61
April	82.4	62.1	72.3	89	50	0	2	0	313	0.21	86	47	12.8	74
May	86.5	66.4	76.5	92	55	7	0	0	516	1.56	91	54	11.8	81
June	88.7	72.7	80.7	94	66	14	0	0	738	4.34	87	60	11.3	82
Year Average or Total	80.3	61.9	71.1	-		80	820	674	4883	35.5	88	59	11.2	66
30-Year Average	81.2	63.3	72.3	-	-	85	674	-	-	49.94	88	57	8.6	66

Key to columns-

A = temperature averages-daily maximum F^o
B = temperature averages-daily minimum F^o
C = temperature averages-monthly average F^o
D = temperature extremes-highest F^o
E = temperature extremes-lowest F^o
F = temperature-number of days 90^o and above, F^o
G = heating degree days

H = average heating degree days for 30-year period
I = cooling degree days (based on formula given)
J = total precipitation (inches)
K = relative humidity at 7:00 a. m. (percentage)
L = relative humidity at 1:00 p. m. (percentage)
M = average hourly wind speed (MPH)
N = percentage of possible sunlight

The number of cooling degrees per day was computed by the formula:

> (Minimum Temperature minus 55°) + (Maximum Temperature minus 85°).

Negative values in either term of the above formula were arbitrarily given the value of zero. This formula is used for computing the cooling load in commercial buildings. Since no formula had been developed for school conditions, the commercial formula was used.

The 1961-62 data given in Table II-3 report only those days during which the schools were in operation. The total of 186 school days includes 180 days with students in attendance and six days of teacher in-service activities. The table entitled "Cooling and Heating Degree Days" shows the months from September through June. The number of school days in each month is reported in Column A, the number of cooling degree days in Column B, and the number of heating degree days in Column D. Each monthly entry in Columns B and D was divided by the number of days in that month to obtain the average number of cooling and heating degrees per day. These averages are reported in Column C and E, respectively. Taking January as an example, there were 22 school days having 52 cooling degree days with an average of 2. 4 cooling degrees per day. At the same time during the month, there were 138 heating degree days with an average of 6. 3 heating degrees per day. For the 1962-63 data given in Table II-4 the same coding is used and the table is read in the same way as the table reporting the 1961-62 data.

The demand upon the heating and cooling equipment and power supplies may also be viewed in terms of the frequency with which specified numbers of degree days occurred during the days that school was in session. The data in Table II-5 indicate that the number of degree days of heating in any one school day ranged from 0 to 34, inclusive, and that the number of degree days of cooling in any one school day ranged from 0 to 31. Since the first range lies within the second, a single tabulation, 0-34, may be used for both. This tabulation appears as column 1 of the double table. The number of school days requiring the number of degree days of heating specified in each row is reported in columns 2 and 3 and of cooling in column 4 and 5 and in each case the 1961-62 data was supplied first. For example, in 1961-62 there were 145 school days requiring 0 degree days of heating and 30 school days requiring 0 degree days of cooling; 4 school days requiring one degree day of heating and 11 school days requiring one degree day of cooling; etc.

Table II-3. -- 1961-62 Cooling and Heating Degree Days.*

Month	A	B	C	D	E
September	19	442	23.3	-	-
October	22	302	13.7	-	-
November	21	194	9.2	10	0.5
December	11	87	7.9	-	-
January	22	52	2.4	138	6.3
February	20	128	6.4	39	2.0
March	22	96	4.4	82	3.7
April	20	160	8.0	18	0.9
May	23	440	19.1	-	-
June	6	128	21.3	-	-
Total for All School Days	186	2,029	-	287	-

*Key to columns are given following Table II-4.

Table II-4. -- 1962-63 Cooling and Heating Degree Days.*

Month	A	B	C	D	E
September	19	466	24.5	-	-
October	24	314	13.1	1	-
November	17	60	3.5	68	4.0
December	13	5	0.4	167	12.8
January	22	20	0.9	166	7.5
February	20	20	1.0	177	8.9
March	18	146	8.1	31	1.7
April	23	228	9.9	-	-
May	19	341	17.9	-	-
June	5	108	21.6	-	-
Total t School Days	180	1,708	-	610	-

*Key to columns for Tables II-3 and II-4.

Column A = number of days of school
Column B = number of cooling degree days
Column C = average cooling degrees per school day
Column D = heating degree days
Column E = average heating degrees per school day

Table II-5. - - Frequency of Occurrence of School Days Having Specified Number of Degree Days of Heating and/or Cooling

Number Degree Days	Frequency of Days of			
	Heating		Cooling	
	1961-62	1962-63	1961-62	1962-63
0	145	115	30	53
1	4	2	11	9
2	4	4	2	1
3	3	4	8	7
4	5	6	4	6
5	4	6	5	2
6	3	6	8	4
7	3	2	3	4
8	2	5	6	5
9	3	2	4	5
10	2	1	7	5
11	2	4	7	6
12	-	2	12	7
13	-	4	7	8
14	1	6	8	6
15	2	3	9	3
16	1	2	4	2
17	-	1	9	7
18	-	-	3	4
19	-	2	5	2
20	-	-	2	7
21	2	-	5	6
22	-	1	3	1
23	-	-	2	3
24	-	1	5	4
25	-	-	8	4
26	-	-	2	-
27	-	-	1	2
28	-	-	4	3
29	-	-	2	1
30	-	-	-	2
31	-	-	-	1
32	-	-	-	-
33	-	-	-	-
34	-	1	-	-

2

2. Summary of General Climatic Conditions

The three schools in the research project have temperatures and humidities that are quite similar. Other weather data dealing with wind velocity, precipitation and hours of sunlight seem to confirm the assumption that the three schools are within the same microclimate. Therefore, the material presented, such as heating and cooling degree days, should not be a variable within the three schools. The variables that do appear as the results of external climate are the weekly and monthly changes of external climate. They have considerable bearing on heating and cooling costs that will be discussed in a later chapter.

Of particular note from the tables on heating and cooling degree days are the wide variations between the two years for which data are presented. It should be noted that the first year had 15% more days when the temperature was 90° or higher, 35% fewer heating degree days and 10% more cooling degree days than did the second year. The 12 months data reflect the wide difference between the two years. It is much more accurate for purposes of this report to use external weather data for only the days during which the schools were occupied. On this basis the heating and cooling degree days have been presented separately for each year. On this nine months basis, the first year had 54% fewer heating degree days and 17% more cooling degree days than did the second year. This difference between the two school years of the research project should be kept in mind as the chapters dealing with different phases of this study are considered. It is assumed that the differences had their greatest effect upon fuel costs, but they may have affected achievement, comfort, discipline, health and attendance.

B. Specific Temperature and Humidity Conditions

The conditions of temperature and humidity specific to each school during its hours of operation for instructional purposes were also investigated. To obtain these data, instruments for the continuous recording of wet and dry bulb temperatures were stationed inside and outside each of the three schools operated during the academic year. The outside instruments were installed in the manner that is standard with the U. S. Weather Bureau.

Three instruments were used inside Oak Grove and three inside Pinellas Park. In each school one was placed in a room having an east exposure, one in a room having a south exposure, and the third in an interior room. One inside instrument was used inside the third school, Tyrone, in which all classrooms were uniform with respect to exposure. Within the rooms, the relative position of all instruments was uniform.

The total number of instruments available to the research staff was limited. The project budget did not provide funds for the purchase of any such instruments and the above described placement was planned to make optimum use of those loaned by industry.

The summer terms were treated as distinct operations for a number of reasons, including the fact that they operated during the months of June and July, which generally were the hottest and most humid months of the year. Northeast High School was used as the control school because neither Pinellas Park nor Tyrone was used for summer school purposes. It was of finger-type design and quite similar to Tyrone in construction. Oak Grove, the climate controlled school, was used as the experimental school during both summer sessions.

It should be reported that other available schools were inspected by the research staff and Northeast was selected as the location for the summer school studies because that school promised to be more comfortable than other buildings that might have been used just as easily. This choice of the most comfortable building available for summer school was in keeping with normal administrative decisions in such situations. The analyses to be presented in this study are based upon data obtained in the best available non-climate controlled school. They would beyond doubt have been much different if other buildings inspected by the research staff had been used.

During the summer of 1961, one instrument was placed inside and one outside Northeast High School. Three instruments were placed on the inside during the second summer term and the outside instrument was installed as before.

The instruments were installed and their calibrations maintained by an independent engineering firm retained by the project. The discs were read and recordings of dry bulb and wet bulb temperatures and relative humidities were made by a technician who was retained by the project for this work. The data were subject to variable instrument error and to variable human error, but not to systematic error induced by any interest in the outcomes of this study on the part of those handling the data.

From the continuously recorded temperature and humidity data the investigators derived a statistic to represent the temperature and the humidity conditions existing within each school as a whole, over each school day as a whole. The temperature statistics represent dry bulb temperatures and it will be understood that the term "temperature" in this study always implies dry bulb, if not otherwise specified. The humidity statistics represent relative humidities and the term humidity in this study implies relative humidity, if not otherwise specified.

The readings at 9:30 A. M., 12:00 M., and 2:30 P. M. were adopted as representative of conditions throughout each school day. Because of bus schedules and local preferences, the hour of beginning school was not uniform for all schools or for all students within the same school. Neither was the hour of closing. The above hours provided for the taking of readings approximately midway in each third of the school day and were uniform with respect to the effects of the sun and other external factors. The basic data then were the temperature and humidity readings taken from each instrument at the three specified hours of each day.

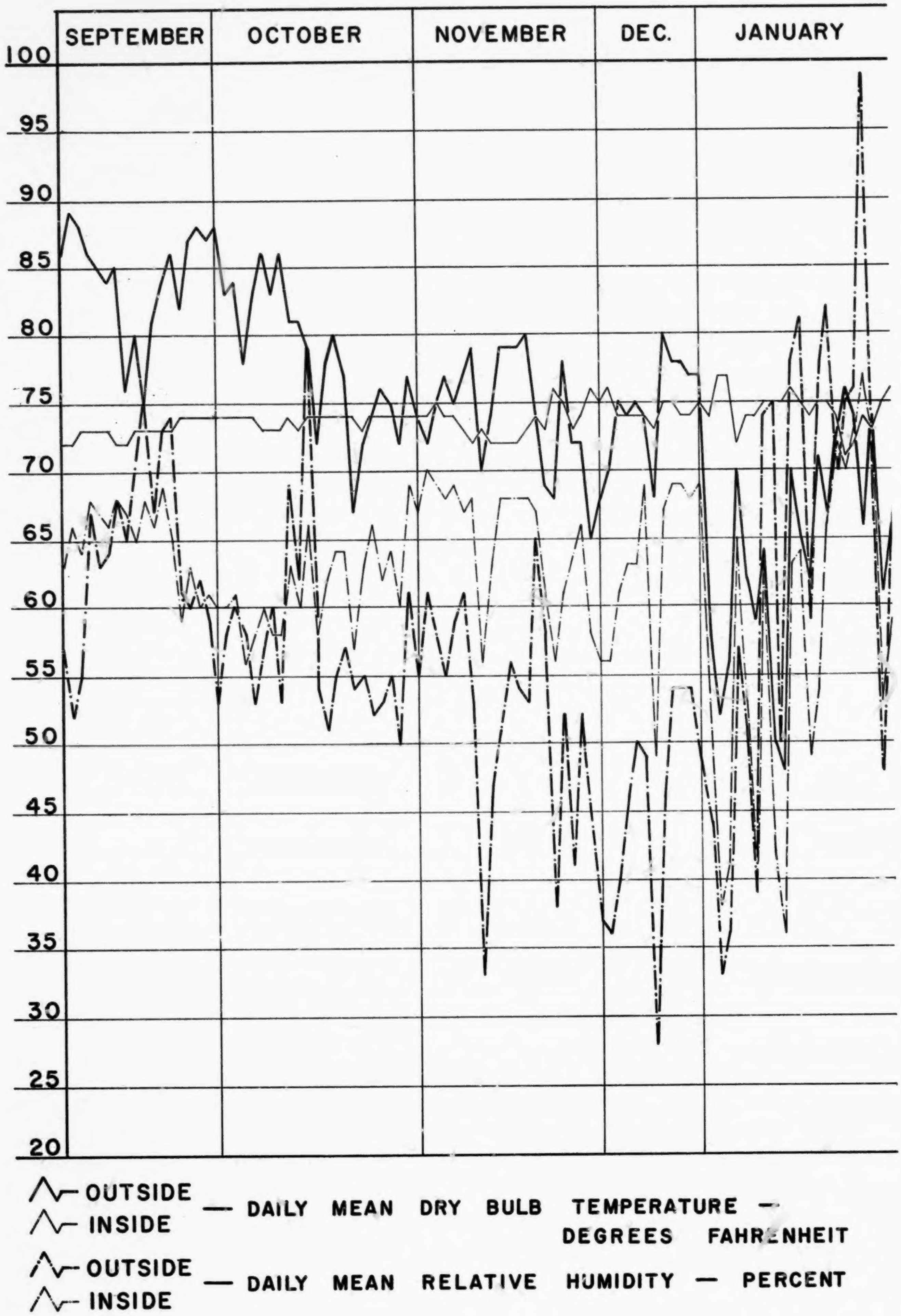
The statistic derived to represent the daily conditions in each building having three inside instruments was the mean of the mid-instrument readings taken at 9:30, 12:00 and 2:30. This method discounted the random errors associated with the instruments, but it also may have discounted systematically the extremes between rooms resulting from their orientation. The systematic effect would have been largest at 9:30 A. M. and would have been produced by ignoring the early morning heat build-up in rooms exposed to the early sun. The net effect would be that of systematically understating the true mean daily temperatures. The net effects upon relative humidity are not clear. The three periodic readings of the single instrument within the third school and outside each school were averaged arithmetically. The daily mean temperatures computed for each building were central tendencies and as such did not represent the daily extremes of temperatures or humidity. For purposes of this study all statistics were rounded to the nearest whole number.

1. Daily Temperature and Humidity Conditions

The inside and outside dry bulb temperatures and relative humidities by days of the academic year 1961-62 are shown in Figures II-1, II-2, and II-3 for Oak Grove, Pinellas Park and Tyrone, respectively. These data show the contrast between the relatively constant inside temperatures of Oak Grove, the climate controlled school, and the fluctuating temperatures of each of the other schools. The quite general tendency for the inside temperatures of Pinellas Park to exceed outside temperatures on relatively hot days should be noted. The inside temperatures at Tyrone, the second non-climate controlled school, tended to be 3-5° lower than outside temperatures under the same climatic conditions. The seasonal differences are also of interest, especially the occurrence of extended periods of hot weather in the fall and spring.

The academic year 1962-63 differed from the previous year in that cool weather occurred earlier in the year and there were a number of days in December, January and February which for the area were considered cold. This difference affected the cost of operation but had little apparent effect upon the inside temperatures other than reducing the extent of the autumn period of high temperatures. The graphical representations of the distribution of temperatures and humidities for the second academic year and for the summer terms are not included in this report because they do not appear necessary for analyses of the data.

FIGURE II-1 OAK GROVE SCHOOL MONTHS -



ACADEMIC YEAR 1961 - 62

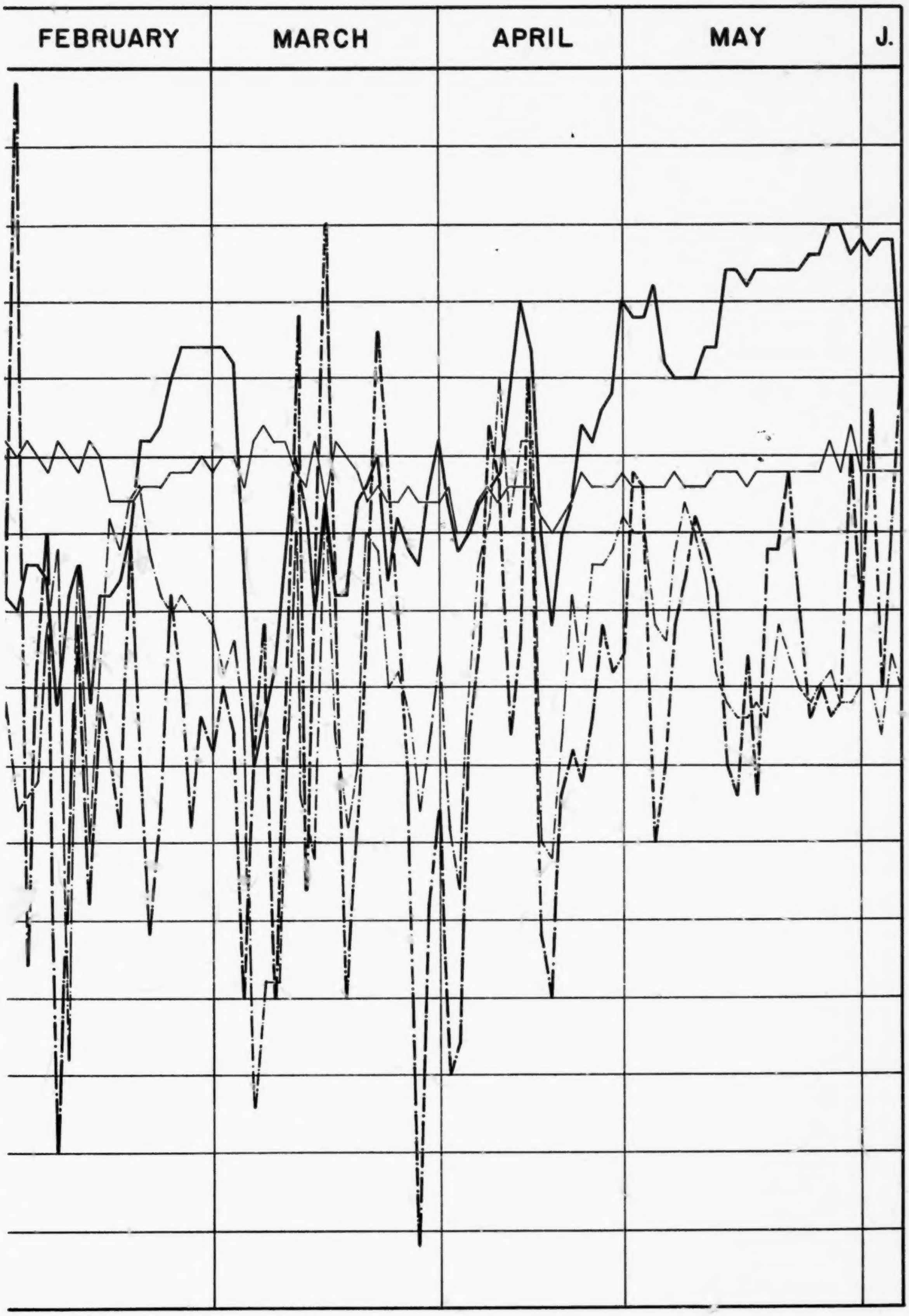
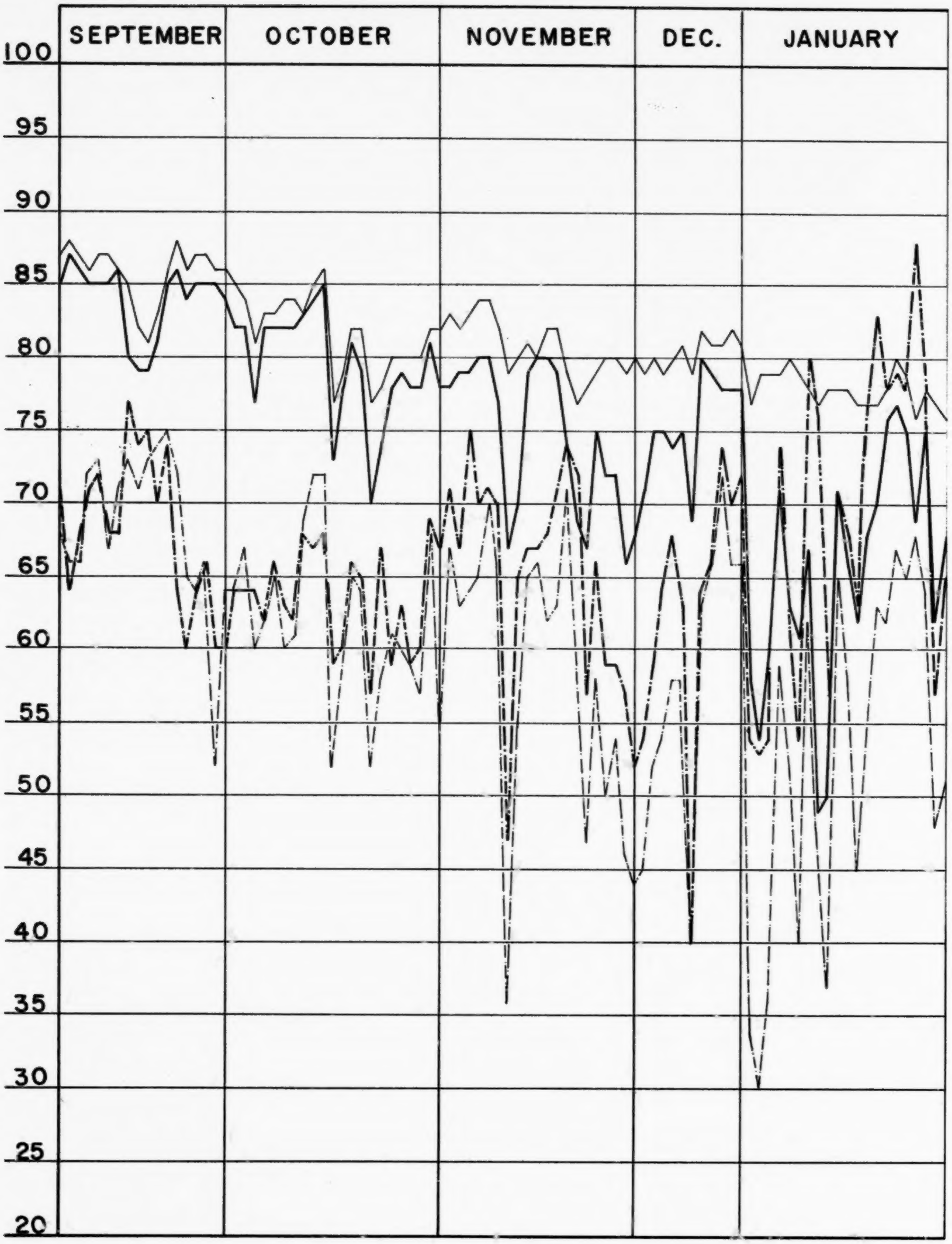


FIGURE II-2 PINELLAS PARK SCHOOL MONTHS —



OUTSIDE
INSIDE — DAILY MEAN DRY BULB TEMPERATURE — DEGREES FAHRENHEIT

OUTSIDE
INSIDE — DAILY MEAN RELATIVE HUMIDITY — PERCENT

ACADEMIC YEAR 1961 – 62

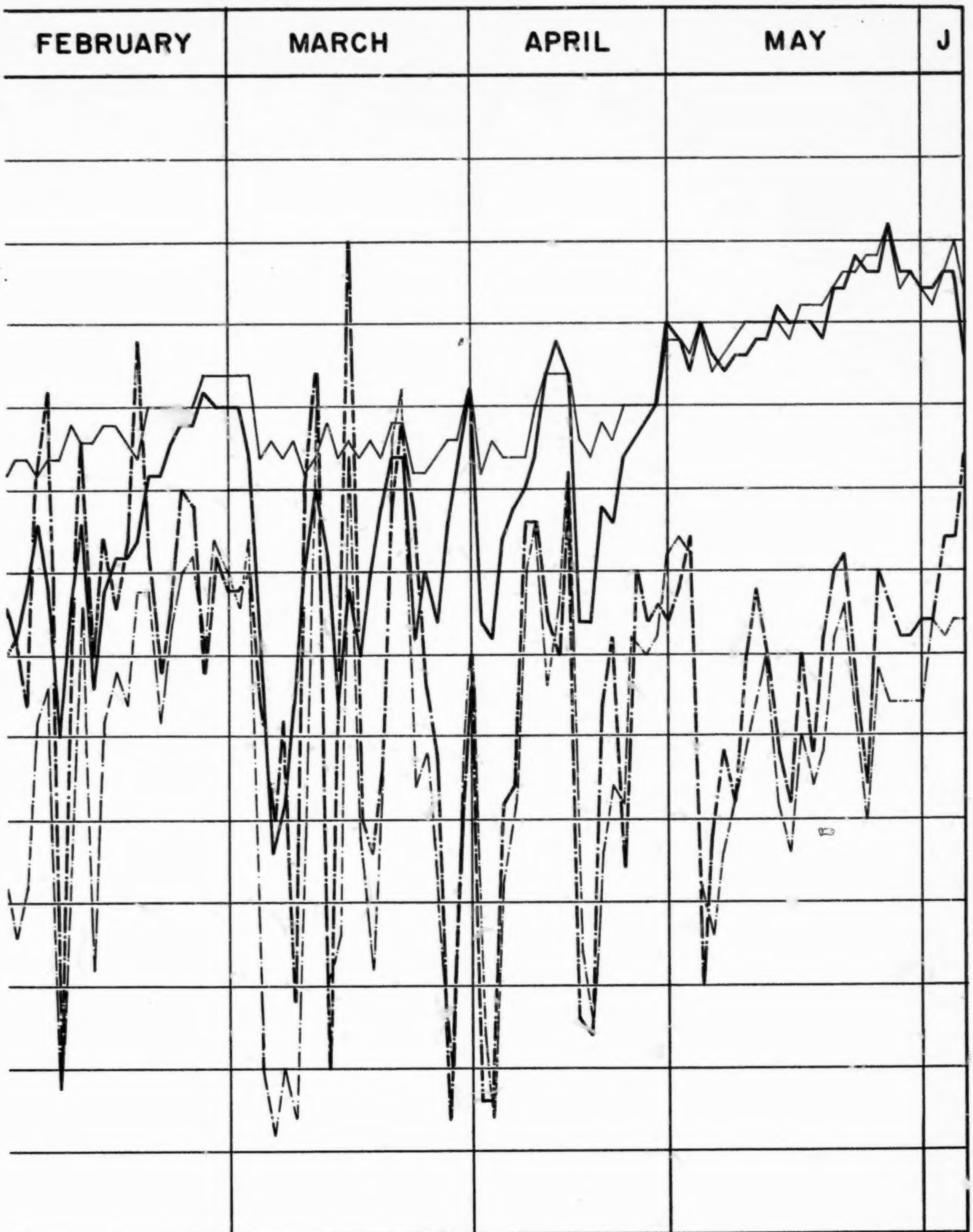
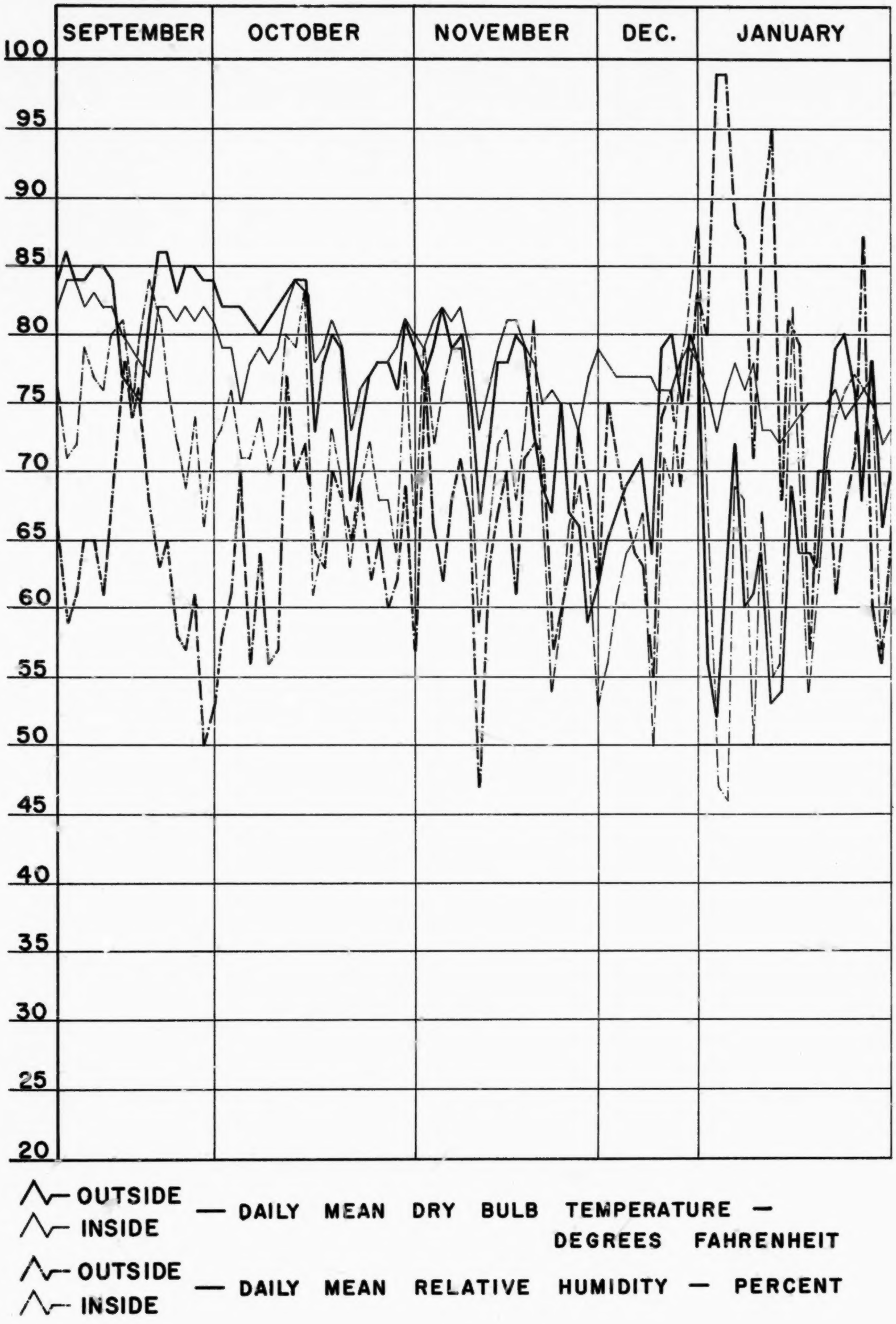
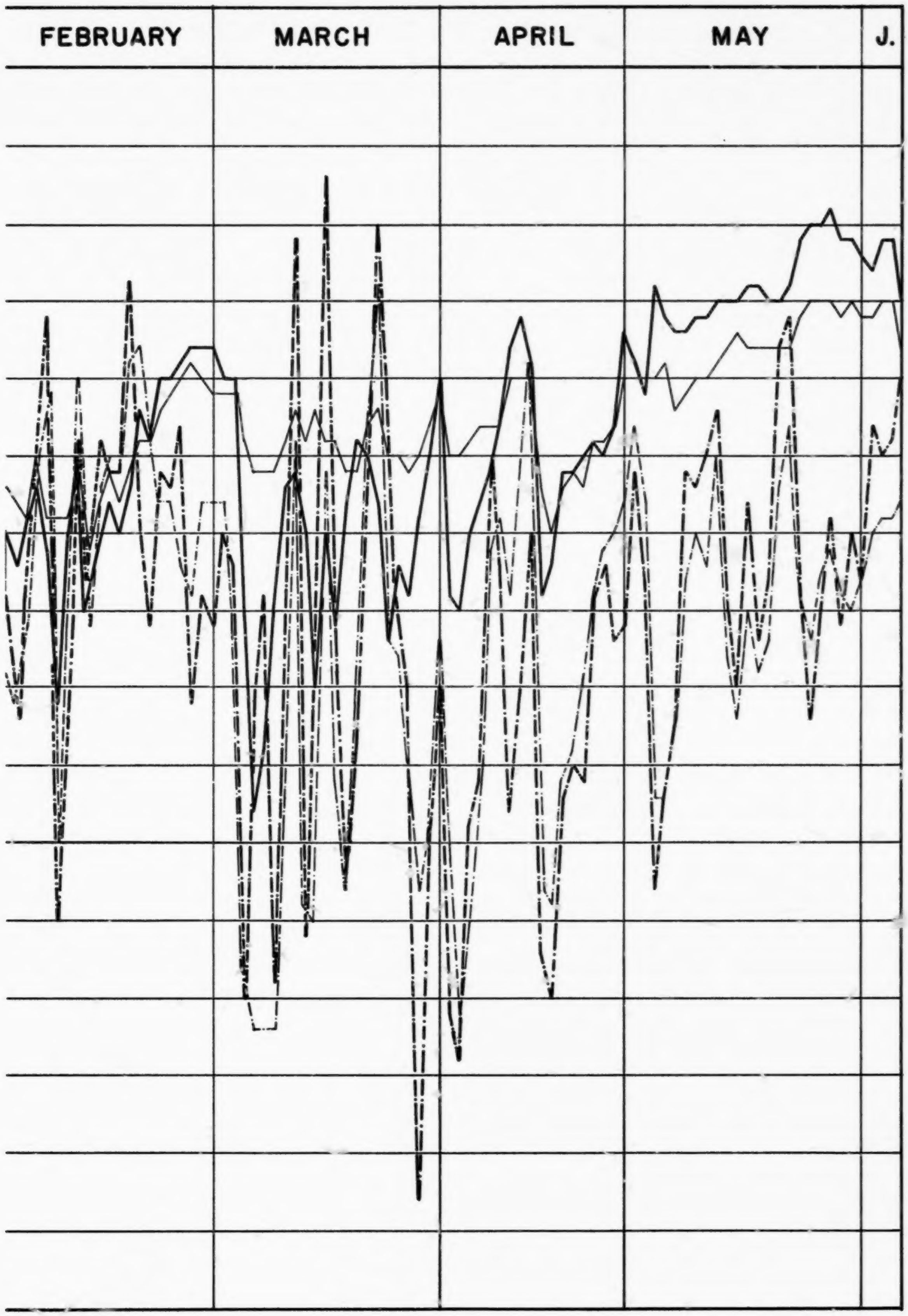


FIGURE II-3 TYRONE SCHOOL MONTHS —



ACADEMIC YEAR 1961 — 62



2. Data on Academic Years

The results of these analyses of temperature and humidity data are reported in Tables II-6, II-7, and II-8 for the academic year 1961-62. Because of technical difficulties no readings were obtained for the first day of school. The remaining 179 school days are included in each table.

The temperatures are reported in bands of 2° and relative humidities in bands of 10%. These units are utilized in further studies based upon these data. The left half of these tables relate to outside conditions and the right half to inside conditions. The columns on the extreme left and right, headed "N," report the number of days having the indicated outside and inside temperatures, respectively. The entries across the bottom of each half report the number of days having relative humidities in the range indicated. The entries in the body of the tables report the number of days having the combination of T/H indicated by the rows and columns.

Data for the academic year 1962-63 are reported in Tables II-9, II-10 and II-11. Because of technical difficulties, data were not available for the first 14 days of school and for four additional days interspersed throughout the school year. If both inside and outside readings were not available for all schools on a given day, that day was not included in the analyses. This policy caused a much greater loss of days during the second year than during the first, but it was necessary if comparisons between schools were to be valid.

The data reported in these tables show that the ranges of the mean daily external temperatures during school hours were practically identical for all schools. During the year 1961-62, for all schools, the lowest temperature was 48° and the highest 91°, a range of 43°. During the year 1962-63, colder weather occurred and the ranges were 55°, 49°, and 51° for Oak Grove, Pinellas Park and Tyrone, respectively. The relative humidities tended to fall within the range of 50 - 79%. Oak Grove tended to be somewhat less humid than the other schools, but it is doubtful that the difference was perceptible.

The inside climatic conditions displayed real differences. During 1961-62 Oak Grove's temperatures fell between 70-77°, a range of 7°. During the same year, Pinellas Park experienced inside temperatures of 76-91°, a range of 15°. Tyrone's temperatures fell between 68-85°, a range of 17°. The most frequently occurring relative humidities were in the 60-69% band at Oak Grove and Pinellas Park during the first year and at all schools during the second. The most frequently occurring humidities at Tyrone were in the 70-79% band during 1961-62. The differences among schools with respect to their internal humidity were small and probably not perceptible on most days.

Table II-6. -- Frequency Distribution of T/H, Outside and Inside Readings Oak Grove, Academic Year 1961-62.

N	T\H	Outside Temperature and Humidity							
		0-29	30-39	40-49	50-59	60-69	70-79	80-89	90-99
2	90				2				
10	88				3	4	3		
17	86				9	7	1		
9	84					6	3		
11	82				5	6			
16	80			1	4	6	3	2	
12	78				10	2			
15	76			2	9	2	1	1	
17	74			4	6	2	3	2	
15	72		1	2	6	2	3		1
10	70		2	2	2	1	3		
12	68	2	3	1	4	2			
13	66			3	4	2	2	1	1
6	64			2		1	1	1	1
2	62				2				
2	60			2					
5	58		2	2		1			
1	56		1						
1	54				1				
1	52		1						
1	50						1		
1	48				1				
179		2	10	21	68	44	24	7	3

Inside Temperature and Humidity								
30-39	40-49	50-59	60-69	70-79	80-89	90-99	H/T	N
3	4	9	2				76	18
1	3	22	56	5			74	87
	1	10	41	15	1		72	68
	2	3		1			70	6
4	10	44	99	21	1			179

Table II-7. -- Frequency Distribution of T/H, Outside and Inside Readings Pinellas Park, Academic Year, 1961-62.

N	T\H	Outside Temperature and Humidity							
		0-29	30-39	40-49	50-59	60-69	70-79	80-89	90-99
1	90					1			
7	88				1	3	3		
9	86				1	6	2		
22	84			1	2	15	4		
16	82				3	9	4		
14	80					10	4		
23	78				2	10	11		
12	76				2	2	8		
15	74				3	6	5	1	
9	72		1		4	1	2	1	
11	70			1	3	3	3	1	
11	68			1	1	3	3	2	1
12	66		2	3	3	2	1	1	
2	64				1	1			
6	62			1	1	4			
3	60			1	2				
1	58				1				
1	56					1			
	54								
1	52				1				
2	50			1	1				
1	48						1		
179			3	9	32	77	51	6	1

Inside Temperature and Humidity								
30-39	40-49	50-59	60-69	70-79	80-89	90-99	H/T	N
			1				90	1
		1	6	1			88	8
		1	14	5			86	20
		7	7	6			84	20
	1	3	14	6			82	24
	1	8	12	7			80	28
9	10	10	14	3	1		78	47
2	7	15	5	1	1		76	31
11	19	45	73	29	2			179

Table II-8. -- Frequency Distribution of T/H, Outside and Inside Reading Tyrone School, Academic Year 1961-62.

N	T\H	Outside Temperature and Humidity							
		0-29	30-39	40-49	50-59	60-69	70-79	80-89	90-99
3	90				1	1	1		
6	88					3	3		
7	86			1	1	3	2		
23	84				4	11	5	3	
14	82				6	5	3		
18	80				2	8	8		
14	78				1	9	3	1	
12	76				1	7	4		
13	74				4	4	4	1	
15	72			1	1	6	4	2	1
10	70	1		1	2	4	1		1
9	68			1	1	3	1	3	
8	66		1	2	1	2	2		
11	64		1	2	2	2	3	1	
5	62				1	1	1	1	1
3	60					1	1	1	
2	58			1		1			
2	56					1		1	
	54								
2	52				1				1
	50								
2	48					1			1
179		1	2	9	29	73	46	14	5

Inside Temperature and Humidity								
30-39	40-49	50-59	60-69	70-79	80-89	90-99	H/T	N
			7	6			84	13
		1	6	10	4		82	21
		2	6	15	2		80	25
	1	4	9	18	4		78	36
	4	8	11	9	2		76	34
4	3	4	7	7	2		74	27
	2	7	5	2	1		72	17
	1	1	2	1			70	5
			1				68	1
4	11	27	54	68	15			179

Table II-9. -- Frequency Distribution of T/H, Outside and Inside Readings Oak Grove, Academic Year, 1962-63.

Outside Temperature and Humidity

N	T \ H	0-29	30-39	40-49	50-59	60-69	70-79	80-89	90-99
1	88						1		
8	86				1	3	4		
14	84				4	8	2		
17	82				4	11	1	1	
11	80			2	5	3	1		
9	78			2	3	3	1		
8	76	1	1		1	2	3		
12	74			2	2	3	2	2	1
4	72			1		1		2	
8	70				1	2	2	2	1
6	68			2		1	1	2	
9	66				1	2	4	2	
5	64			1	1		2		1
9	62			1	1	1	3	2	1
7	60				2	2	1	1	1
10	58		1	2	1	2	1	2	1
4	56					2	1	1	
7	54			1	2	1	1	1	1
5	52				2	1			2
4	50		1		1	2			
2	48			1				1	
1	46				1				
	44								
	42								
	40								
	38								
	36								
1	34			1					
162		1	3	16	33	50	31	19	9

Inside Temperature and Humidity

20-29	30-39	40-49	50-59	60-69	70-79	80-89	90-99	H / T	N
			1					80	1
	1		3	1				78	5
	1	6	9	7	1			76	24
	2	7	28	43	11			74	91
		2	17	16	5			72	40
				1				70	1
	4	15	58	68	17				162

Table II-10. -- Frequency Distribution of T/H, Outside and Inside Readings Pinellas Park, Academic Year, 1962-63.

Outside Temperature and Humidity

N	T \ H	0-29	30-39	40-49	50-59	60-69	70-79	80-89	90-99
2	90				1	1			
9	88				3	4	2		
10	86				2	4	4		
14	84				6	3	5		
10	82				1	1	6	2	
5	80				1	2	1	1	
17	78		1		1	6	4	5	
10	76			1	1		5	3	
8	74			1	1	2	4		
8	72			1		2	4	1	
9	70			1	1	3	2	2	
6	68		1	1	1		3		
17	66			4	2	9	2		
6	64		1			2	2	1	
3	62			1	1		1		
11	60		1	2	5	2	1		
8	58			4	1	2		1	
1	56						1		
4	54		1	1	1			1	
2	52		1			1			
1	50					1			
	48								
	46								
	44								
1	42			1					
162			6	18	29	45	47	17	

Inside Temperature and Humidity

20-29	30-39	40-49	50-59	60-69	70-79	80-89	90-99	H / T	N
				4	2			88	6
			3	15	4			86	22
				4	3	3		84	10
		1	1	2	6			82	10
	4	2	2	5	3	3		80	19
	8	16	16	16	7	1		78	64
1		8	6	8	2	1		76	26
			1		2			74	3
		1						72	1
		1						70	1
1	12	29	29	54	29	8			162

Table II-11. -- Frequency Distribution of T/H, Outside and Inside Readings Tyrone, Academic Year, 1962-63.

Outside Temperature and Humidity

N	T \ H	0-29	30-39	40-49	50-59	60-69	70-79	80-89	90-99
1	90				1				
6	88				3	2			
9	86				1	5	3		
7	84				1	4	1	1	
10	82					5	3	2	
20	80				9	3	7	1	
7	78					4	1	2	
10	76	1	1	1	1	1	2	2	1
6	74			1	1	1	2	1	
8	72				1		5	1	1
8	70			1	1	2	2	2	
1	68					1			
12	66		1	3	2	1	2	2	1
10	64			2		2	3	1	2
10	62		1	1	2	2	4		
4	60			1			1	2	
5	58		1		1		1		2
9	56			1	3	2	1	2	
7	54				3	3	1		
2	52				1				1
3	50			1		1			1
3	48			1	1				1
3	46			2	1				
	44								
	42								
1	40						1		
162		1	4	15	33	39	40	20	10

Inside Temperature and Humidity

20-29	30-39	40-49	50-59	60-69	70-79	80-89	90-99	H / T	N
				2	3			86	5
			1	11	6	2		84	20
				3	1	6		82	10
				3	1	6	3	80	13
		1	3	3	3	10	4	78	24
		6	8	6	7	3		76	30
		5	11	14	7	2		74	39
	1	1	6	6	2	1		72	17
			2	2				70	4
	1	13	31	50	30	30	7		162

3. Data on Summer Schools

The mean daily dry bulb temperatures and relative humidities during the summer sessions were computed as previously explained. The method was modified by dropping the 2:30 P. M. readings and basing mean daily temperatures and humidities upon the 9:00 A. M. and 12:00 M. readings. The reason for this change was the fact that each school day ended at noon.

The data for each school for each of the two summers are reported in Tables II-12 to 15. These data indicate that the external climatic conditions of the two schools were quite similar. The most frequently occurring temperatures were between 84-87°, and the most frequently occurring relative humidities were between 70-79%.

The inside climatic conditions differed both in terms of temperature and humidity. During the summer of 1961-62, 26 of the 29 school days at Northeast experienced temperatures higher than any at Oak Grove and during 1962-63 all days at Northeast were hotter than the highest mean daily temperature at Oak Grove. The relative humidities appear to be about 10% greater at Northeast than at Oak Grove.

4. Summary

The data presented in this chapter show that the schools involved in this study were in the same microclimate and support the general descriptions of the climate given by the U. S. Weather Bureau. The number of heating degree days was 512 and 820 for the first and second years, respectively. The number of cooling degree days for each of the two years was 5241 and 4883. The relative humidity often fluctuated widely from day-to-day and within the same day.

The temperatures maintained within Oak Grove, the climate controlled school, rarely exceeded 77°. The temperatures at Tyrone were fairly evenly distributed about 77°, while the preponderance of those at Pinellas Park and at Northeast exceeded that reading. Pinellas Park actually operated as a heat sink during many of the hottest days of the school year and Northeast behaved in the same manner on occasion. Differences with respect to interior humidity among the three schools operated during the academic year were temporary and, on the average, were small. Northeast appeared to be about 10% more humid than was Oak Grove during the summer months.

Table II-12. -- Frequency Distribution of T/H, Outside and Inside Readings Oak Grove Summer, 1961.

N	T\H	Outside Temperature and Humidity				Inside Temperature and Humidity					H/T	N
		60-69	70-79	80-89	90-99	50-59	60-69	70-79	80-89	90-99		
14	86	1	12	1								
5	84		2	3								
5	82		2	1	2							
2	80		1	1			1				80	1
1	78				1		3	1			78	4
1	76			1			22				76	22
1	74				1	2					74	2
29		1	17	7	4	2	26	1				29

Table II-13. -- Frequency Distribution of T/H, Outside and Inside Readings Northeast Summer, 1961.

N	T\H	Outside Temperature and Humidity				Inside Temperature and Humidity					H/T	N
		60-69	70-79	80-89	90-99	50-59	60-69	70-79	80-89	90-99		
1	90		1									
4	88	1	3				1	1			88	2
14	86	1	11	2			3	9			86	12
6	84	1	3	2			1	9	1		84	11
1	82	1					1				82	1
2	80			1	1				1		80	1
	78									1	78	1
1	76				1					1	76	1
29		4	18	5	2		6	19	2	2		29

Table II-14. -- Frequency Distribution of T/H, Outside and Inside Readings Oak Grove Summer, 1962.

N	T\H	Outside Temperature and Humidity				Inside Temperature and Humidity					H/T	N
		60-69	70-79	80-89	90-99	50-59	60-69	70-79	80-89	90-99		
3	88	2	1									
9	86	2	5	2								
8	84		5	3								
1	82			1								
1	80			1								
	78					11	3				78	14
1	76				1	5	5				76	10
1	74				1							
24		4	11	7	2	16	8					24

Table II-15. -- Frequency Distribution of T/H, Outside and Inside Readings Northeast Summer, 1962.

N	T\H	Outside Temperature and Humidity				Inside Temperature and Humidity					H/T	N
		60-69	70-79	80-89	90-99	50-59	60-69	70-79	80-89	90-99		
							2				90	2
3	88	2	1				7	1			88	8
9	86	2	5	2			5	4	1		86	10
8	84		5	3				1	1		84	2
1	82			1					1		82	1
1	80			1					1		80	1
	78											
1	76				1							
1	74				1							
24		4	11	7	2		14	6	4			24

CHAPTER III

AREAS, VOLUMES AND COSTS OF CONSTRUCTION

The Pinellas County Board of Public Instruction commissioned Charles Colwell, architect, to design a "good, naturally-ventilated school" for this climate and community. At approximately the same time, it commissioned Bruce & Parrish, architects, to design a "good climate-controlled school" for this climate and community, waiving such building codes as provided for adequacy of natural ventilation. Both schools when completed provided 24 classrooms and adequate administrative and general and special service areas.

The Board was primarily concerned that it receive the best possible school for the funds available in both cases. The Board made clear to the architects, engineers, contractors, and suppliers that it intended to use the two schools for comparative studies of costs of construction and operation and studies of educational outcomes associated with climatic conditions. It proceeded to implement its plans for research while the buildings were being designed and constructed.

The contracts for the climate controlled school, Oak Grove, and for the non-climate controlled school, Pinellas Park, were awarded to Settecasi & Chillura and William H. Dean, respectively. There were probably no great differences in the general labor market nor in the basic costs of the materials. Other factors which are presently unidentified may have operated.

The research staff holds that these two schools should be considered specific cases and not statistical samples. It cautions the reader not to place any appreciable confidence in any generalizations he may be tempted to make, because of the variables of community, climate, educational programs, and local conditions which influenced contract costs.

The data on areas and/or volumes are presented through four methods of calculation, as follows: according to the American Standards Association Designations; by definitions of the American Institute of Architects; and by two local alternates.

A. American Standards Association Designations

The designations of spaces provided by the American Standards Association furnish a useful basis upon which to compare the amount of space devoted to the principal educational uses. This method proved not to be as suitable for the analysis of costs as did the three other methods of analyzing the buildings which will be presented later.

The applicable Gross Area Designations[1] of the American Standards Association are defined as follows:

1.1 Gross area of a building is the sum of the areas at each floor level included within the principal outside faces of exterior walls, neglecting architectural setbacks or projections.

1.4 Exclude all unroofed areas and unenclosed roofed-over spaces.

Subdivisions of Gross Area

2.2.1 Instruction areas shall include such areas as:

(1) Classrooms shall include rooms designed for or adapted to accommodate and used for regularly scheduled group instructions, and including the so-called regular classrooms, special use classrooms such as laboratories and shops. Storage and other service areas opening into and serving as an adjunct to a particular classroom should be considered a part of that classroom area.

(2) Other instruction areas shall include such areas as libraries, research laboratories, museums, instructors' offices and multi-purpose rooms (if used primarily for instruction purposes) and may include such areas as auditoriums and gymnasiums when used principally for instruction.

2.2.2 Administration areas shall include all areas devoted to school business activities, pupil personnel management, and public relations where such areas are not designated for other purposes. Administrative areas are such as:

(1) Administrative offices (general and departmental), waiting rooms, conference rooms

(2) Guidance offices, record service, and administrative storage areas

(3) Clinic, infirmary, and other health service areas.

---

[1] American Standards Association, Areas in School Buildings 70 East Forty-Fifth St., New York, N. Y., 1958.

2.2.4 Service areas shall include all functional and building service areas not otherwise classified. Service areas are such as:

(1) General toilets, excluding those in classrooms, offices or shower rooms, and serving only those areas

(2) Storage rooms and spaces, such as building supply or service storage

(3) Teacher lounges and rest rooms

(4) Lunchrooms, cafeterias, and kitchens, including their service and storage areas

(5) Mechanical service areas, including furnace rooms, fan rooms, and heat or ventilating tunnels (if included in gross area)

(6) Building service areas, including such areas as custodial quarters, building repair shops, custodial service closets.

2.2.5 Circulation areas shall include such areas as are used for general traffic, omitting such areas as unit-contained corridors and stairs located within and serving parts of a unit or suite, but including such as:

(1) Enclosed corridors, including extensions into deep recessed doors or entry ways

(2) Stairs, elevators, ramps, and escalators

(3) Foyer and vestibule areas, including the recessed entrances described as a part of the gross area.

2.2.6 Construction areas shall include all areas of exterior walls and interior walls. (Other sections of this classification do not apply.)

The gross areas of the principal sections of each of the two buildings as designated by the ASA are reported in Table III-1. The total areas reported in this table actually omit spaces in each building that, with minor modifications in construction, would have been included. If doors had been installed at the ends of the malls at Oak Grove, then all double loaded corridor areas would have been included and the total area would have been 74,283 square feet. The installation of doors at the ends of the double loaded administrative mall at Pinellas Park would have yielded a total of 68,592 square feet at that building.

Table III-1. -- Gross Areas by ASA Designations

Code	Definition	Oak Grove	Pinellas Park
1.1-1.4	GROSS AREA -		
	Administration	5,932	3,411
	Library	above	2,667
	Shop	8,632*	4,370
	Homemaking	above	2,860
	Cafeteria, auditorium, Gymnasium	22,465	25,461*
	Three classroom sections	22,917	27,129
	Power plant	1,480	320
	Cooling tower	315	-
	TOTAL GROSS AREA	61,741	66,398

*Also includes bandroom

The gross areas reported in Table III-1 were subdivided in accordance with the ASA designations. Instruction and Administration areas are reported in Table III-2, service areas in Table III-3, and circulation and construction areas in Table III-4. The areas in the two buildings devoted to instruction and administration are quite closely comparable. The climate controlled building contained approximately 50% more space devoted to general service than did the non-climate controlled building. The greatest differences between the two buildings occurred in the case of circulation areas and in the case of construction areas. These data reflect the differences between the compact and the open, campus type buildings.

Table III-2. -- Instruction and Administration Areas by ASA Designations

Code	Definition	Oak Grove	Pinellas Park
2. 2. 1	INSTRUCTION AREAS		
(1)	Classrooms with adjacent instructional areas, storage, closets, offices:		
	Single classrooms	12, 128	8, 964
	Double classrooms	6, 240	9, 960
	Homemaking	2, 531	2, 656
	Band room	1, 333	1, 364
	Shop and drafting	3, 850	3, 936
		26, 082	26, 859
(2)	Other instructional areas including necessary adjacent spaces:		
	Gymnasium	7, 929	7, 860
	Boys' lockers	1, 360	1, 313
	Girls' lockers	1, 360	1, 334
	Teaching auditorium	2, 906	3, 576
	Library	2, 311	2, 182
		15, 866	16, 265
	TOTAL INSTRUCTION AREAS	41, 948	43, 124
2. 2. 2	ADMINISTRATIVE AREAS		
(1)	Administrative Offices		
	Principal	188	203
	Assistant principal	133	106
	General office	637	707
	General office workroom	115	108
	General conference	259	179
		1, 332	1, 303
(2)	Supplementary Administrative Space:		
	Guidance	114	134
	Book storage	130	117
		244	251
(3)	Health services:		
	Clinic	306	267
	TOTAL ADMINISTRATIVE AREAS	1, 882	1, 821

Table III-3. -- Service Areas by ASA Designations

Code	Definition	Oak Grove	Pinellas Park
2.2.4	SERVICE AREAS		
(1)	General toilets:		
	In classroom areas	1,312	816
	In library	-	112
	In shop	-	75
	In band, gymnasium, auditorium, cafeteria	-	277
		1,312	1,280
(2)	Storage rooms and spaces:		
	In band, gymnasium, auditorium, cafeteria	236	130
(3)	Teacher lounges and restrooms	509	498
(4)	Lunchrooms, cafeterias and kitchens	6,237	5,590
(5)	Mechanical service areas:		
	In classrooms	648	216
	Administration-library	-	50
	Gymnasium, auditorium, cafeteria	779	404
	Power plant	1,443	264
	Home economics, band, shop	232	-
		3,102	934
(6)	Building service areas:		
	Classrooms	704	294
	Administration-library	47	70
	Gymnasium, auditorium, cafeteria	213	86
	Power plant	171	-
		1,135	450
	TOTAL SERVICE AREAS	12,531	8,882

Table III-4. -- Circulation & Construction Areas by ASA Designations

Code	Definition	Oak Grove	Pinellas Park
2.2.5	CIRCULATION AREAS		
(1)	Only circulation areas enclosed by doors:		
	Corridors between classrooms		4,032
	Administration and library corridors	659	523
	Gym, auditorium, locker entries, halls, cafeteria	69	1,173
		728	5,728
(2)	Stairs, ramps, elevators (these do not apply)	-	-
(3)	Foyers, vestibules, recessed entrances, lobbies:		
	Lobbies in auditorium	-	887
	Auditorium-gymnasium	228	-
	Power plant entry	56	-
	TOTAL CIRCULATION AREAS	1,012	6,615
2.2.6	CONSTRUCTION AREAS		
	Exterior and interior wall areas	4,368	5,956
	TOTAL CONSTRUCTION AREAS	4,368	5,956

The summary table, III-5, facilitates the comparisons of the buildings in terms of the principal designations and gross areas.

Table III-5. -- Summary of Areas According to American Standards Association Designations

Code	Designation	Oak Grove	Pinellas Park
2.2.1	Instruction (Net)	41,948	43,124
2.2.2	Administrative (Net)	1,882	1,821
2.2.4	Service (Net)	12,531	8,882
2.2.5	Circulation (Net)	1,012	6,615
2.2.6	Construction (Net)	4,368	5,956
1.1-1.4	Gross Area	61,741	66,398

The data reported in Tables III-6 and III-7 indicate the distribution over the several ASA designations of the space within the sections. The sections have been lettered A-G at Oak Grove to conform with the architects' designations. The reader will note that Section G, which was added to the original plan, comprises eight classrooms and is reported in a column adjacent to that of the A and B classrooms. At Pinellas Park the sections have been numbered 1-9 to conform with the architects' designations. The coding of the designations was presented at the beginning of this section of this report.

Table III-6. -- Areas Within Sections of Oak Grove

Code	A & B	G	C	D	E	F	Totals
2. 2. 1							
(1)	12,304	6,064	7,714	-	-	-	26,082
(2)	-	-	-	13,555	2,311	-	15,866
							41,948
2. 2. 2							
(1)	-	-	-	-	1,332	-	1,332
(2)	-	-	-	-	244	-	244
(3)	-	-	-	-	306	-	306
							1,882
2. 2. 4							
(1)	874	438	-	-	-	-	1,312
(2)	-	-	-	236	-	-	236
(3)	-	-	-	-	509	-	509
(4)	-	-	-	6,237	-	-	6,237
(5)	408	240	232	779	-	1,443	3,102
(6)	466	238	-	213	47	171	1,135
							12,531
2. 2. 5	-	-	-	297	659	56	1,012
2. 2. 6	1,226	659	686	1,148	524	125	4,368
GROSS	15,278	7,639	8,632	22,465	5,932	1,795	61,741

Key to columns in table

Sections	Function of Sections
A & B	Original 16 classrooms
G	Eight-classroom addition
C	Homemaking, band, shop
D	Gym, auditorium, cafeteria
E	Administration, library
F	Power plant, cooling tower

Table III-7. -- Areas Within Sections of Pinellas Park

Code	1,2,3	4,5	6	7	8	9	Totals
2.2.1							
(1)	18,924	-	2,656	3,936	1,343	-	26,859
(2)	-	2,182	-	-	14,083	-	16,265
							43,124
2.2.2							
(1)	-	1,303	-	-	-	-	1,303
(2)	-	251	-	-	-	-	251
(3)	-	267	-	-	-	-	267
							1,821
2.2.4							
(1)	816	112	-	75	277	-	1,280
(2)	-	-	-	-	130	-	130
(3)	-	498	-	-	-	-	498
(4)	-	-	-	-	5,590	-	5,590
(5)	216	50	-	-	404	264	934
(6)	294	70	-	-	86	-	450
							8,882
2.2.5	4,032	523	-	-	2,060	-	6,615
2.2.6	2,847	822	204	359	1,668	56	5,956
GROSS	27,129	6,078	2,860	4,370	25,641	320	66,398

Key to columns in table

Sections	Function of Sections
1, 2, 3	24 classrooms
4 and 5	Library, administration
6	Homemaking
7	Shop
8	Band, gym, auditorium and cafeteria
9	Power house

The reporting of space in accordance with the American Standards Association Designations caused the omission of 21,117 square feet of usable space at Oak Grove and 22,251 square feet of such space at Pinellas Park. The space is not completely enclosed but is usable, and commonly included, in schools in the region. The types and amounts of such space are reported in Table III-8.

Table III-8. -- Areas in Addition to those Covered by ASA Designations

Areas	Oak Grove	Pinellas Park
Covered, double-loaded corridors, ends not enclosed:		
Between classrooms	3,584	-
Between gym, shop, cafeteria, administration	4,309	-
Main mall and extension by library	4,849	-
Library-administration mall	-	2,193
	12,742	2,193
Covered, not double-loaded areas:		
East classroom corridor	763	-
Classroom malls and extensions	-	5,940
Walkways and entries	3,980	7,450
	4,743	13,390
Uncovered walkways	3,632	6,668

B. Definitions of American Institute of Architects

The definitions of the American Institute of Architects furnish a second basis for the reporting of areas, and also a basis for the reporting of volumes of school buildings. The definitions of the Institute are as follows:[2]

Architectural Area of Buildings

> The architectural area of a building is the sum of the areas of the several floors of the building, including basements, mezzanine and intermediate floored tiers and penthouses of headroom height, measured from the exterior faces of exterior walls or from the center line of walls separating buildings.
>
> Covered walkways, open roofed-over areas that are paved, porches and similar spaces shall have the architectural area multiplied by an area factor of 0. 50.
>
> The architectural area does not include such features as pipe trenches, exterior terraces or steps, chimneys, roof overhangs, etc.

Architectural Volume of Buildings

> The architectural volume (cube or cubage) of a building is the product of the total areas defined above and the height from the average depth of footings to finish floor, floor to floor, to the average height of the surface of the finished roof above, for the various parts of the building.

Tables III-9 and III-10 that follow report gross area and volume by AIA definition for each school. The slight differences in grouping of certain rooms or services areas are dictated by the design of the facilities. Corridors contained within the buildings are included as full value and all others are carried at one-half value. Further elaboration of these circulation areas is given in the section "Local Alternates to AIA Definitions". For purposes of calculating the volume of each school, it was established that the average depth of footings to finish floor was three feet.

---

[2] AIA Document No. D-101 (Formerly 239) 1958 Edition.

Table III-9. -- Oak Grove Gross Area and Volume by A. I. A. Definitions

Designation	Area	Volume
Administration	3,364	47,376
Library	2,568	40,446
Shop + homemaking + band	8,632	121,567
Cafeteria + auditorium + kitchen	11,244	235,655
Gymnasium	8,034	232,651
Lockers	2,987	42,066
Three classroom buildings	22,917	322,747
Power plant	1,480	27,750
Roof mechanical building	200	2,975
Cooling tower	315	3,780
Area and volume of separate buildings	61,741	1,077,013
Double-loaded covered classroom corridors 3,584 @ .5 =	1,792	25,237
Double-loaded malls 9,158 @ .5 =	4,579	68,685
East corridor 763 @ .5 =	382	4,806
Covered walkways and entries 3,980 @ .5 =	1,990	25,041
TOTAL GROSS AREA	70,484	
TOTAL GROSS VOLUME		1,200,782

Table III-10. -- Pinellas Park Gross Area and Volume by A. I. A. Definitions

Designation		Area	Volume
Administration		3,411	46,617
Library		2,667	36,449
Shop		4,370	59,723
Homemaking		2,860	40,993
Cafeteria + auditorium + stage		7,912	134,504
Gymnasium		7,988	227,658
Band + kitchen + lockers		9,741	133,127
Three classroom buildings		27,129	370,763
Electric vault		320	4,053
Area and volume of separate buildings		66,398	1,053,887
Double-loaded library-administration mall	2,194 @ .5 =	1,097	14,992
Classroom malls	6,916 @ .5 =	3,458	47,259
Covered walkways and entries	7,450 @ .5 =	3,725	38,491
TOTAL GROSS AREA		74,678	
TOTAL GROSS VOLUME			1,154,629

The data reported show Pinellas Park, the non-climate controlled school, to be approximately 4,200 square feet larger in area and approximately 46,000 cubic feet smaller in volume than Oak Grove. The data will be used in a later section as one basis for comparing the costs of the two buildings.

C. Local Alternates to AIA Definitions

The first local alternate is calculation of all double loaded spaces at full value, instead of at .5. The reason for considering the alternate of full value for mall and corridor areas at Oak Grove is that malls and corridors are double loaded and would require only doors at their ends to qualify for full value treatment according to definitions of the American Institute of Architects. Also, these areas have complete ceilings that are fully insulated and they present the same appearance as other fully-enclosed areas. At Pinellas Park similar double loaded area is of exposed beam construction. The results, based upon this alternate, are given in Table III-11.

Table III-11. -- First Alternate Area and Volume Data

Items*	Oak Grove Area	Oak Grove Volume	Pinellas Park Area	Pinellas Park Volume
A	61,741	1,077,013	66,398	1,053,887
B	12,742	187,844	2,194	29,984
C	2,372	29,847	7,183	85,750
D	76,855	1,294,704	75,775	1,169,621

*A = Area and volume of separate buildings (by AIA).
B = Double loaded, covered corridors at full value
C = Single loaded, covered areas at 0.5 value
D = Total area and volume

The second local alternate includes areas of the overhang which were essential in the design of the building. If all building overhang is included at one-third value, this addition would increase Pinellas Park by 3,640 square feet and Oak Grove by 135 square feet. With this additional area Oak Grove would have a total of 76,990 square feet and Pinellas Park would have a total of 79,415 square feet.

The data indicate that the air-conditioned school has 10,000 square feet more covered, double loaded corridors than does the other school; that the naturally ventilated school has approximately 10,000 square feet more non-double loaded walkways than does the air conditioned; and that the naturally ventilated school has about 3,000 square feet more uncovered walkways than does the air conditioned.

D. Capital Costs

The capital costs reported in Table III-12 cover the combination of two base contracts on each building. The original bid and contracts on each building called for sixteen classrooms and their normal complement of supporting rooms. While these contracts were in effect, the need was felt for eight additional classrooms at each school, so bids were let and these additions contracted. The costs of the complete buildings as outlined earlier in this report are presented in Table III-12.

These thirteen cost classifications have been derived from apparently common elements of the "Final Requisition for Payment" sheets submitted by the contractors on all four contracts. It is not recommended that direct comparisons of costs by classification be made. The combination of elements into classifications was somewhat arbitrary because there are differences in the terminology used by contractors, there are various ways of allotting priority on payment sheets, and there are fundamental differences in the designs of the buildings.

Table III-12. -- Capital Costs of Oak Grove and of Pinellas Park as Comparable Buildings

Classifications	Oak Grove	Pinellas Park
Fees, insurance, site preparation, paving, curbing, layout and setup	$ 36,713.00	$ 59,987.00
Form materials, foundation, concrete reinforcing and masonry	98,264.00	92,484.00
Structural and misc. steel, walls, precast beams, deck materials, domes	105,133.00	149,957.00
Finish floors	7,175.00	15,015.00
Labor, supervision, carpentry	39,172.00	78,715.00
Lumber, millwork, special doors	17,700.00	33,624.00
Furring, plaster, insulation	13,497.00	5,750.00
Windows, glass, glazing, doors	19,408.00	50,985.00
Painting, wall coating	18,835.00	21,525.00
Ceramic, acoustical tile, chalk board	34,231.00	15,415.00
Hardware, fascia, misc. metal, equipment	48,264.00	21,745.00
Electrical	66,408.00	83,630.00
Heating, ventilating and plumbing	170,082.00	101,678.00
Total original contract	674,882.00	730,510.00
Change orders	554.16	-443.97
Final Architects' fees	33,786.81	36,503.30
Final Contracted Building Costs	709,522.97	766,569.33
Total Deductions for Building Comparison*	10,374.00	52,718.60
NET COSTS OF COMPARABLE BUILDINGS	699,148.97	713,850.73

*For comparable building costs, it would be necessary to deduct from "Final Contracted Building Costs" the following costs peculiar to the site or beyond actual building costs:

Sewerage lift station	-	4,810.00
Vibroflotation	-	34,910.00
Fences and gates	500.00	-
Paving and curbing	9,380.00	10,012.00
Architects' fees on these deductions	494.00	2,986.60
Total	10,374.00	52,718.60

E. Area, Cubage, and Per-Student Costs

The "net costs of comparable buildings," $699,148.97 for Oak Grove and $713,850.73 for Pinellas Park, were used for computing three types of unit area and volume costs and also for computing the cost per student. The unit costs reported in Line 1, of Table III-13, were based upon the areas and volumes reported in Section B of this chapter. The unit costs reported in Line 2 were based upon areas and volumes reported in section C of this chapter, which were computed by including all double loaded spaces at full value instead of 0.5 value as was done in Line 1. The costs reported in Line 3 were based upon areas obtained by adding to those in Line 2 one third of the area of overhangs.

The design capacity of each building was 930 students. Based upon this capacity, the cost per design student of the Oak Grove School was $751.77 and the cost of the Pinellas Park School was $767.58.

Table III-13. -- Costs Divided by Three Alternate Formulas

Treatment of Data	Oak Grove Per Sq. Ft.	Oak Grove Per Cu. Ft.	Pinellas Park Per Sq. Ft.	Pinellas Park Per Cu. Ft.
1. AIA's area and volume designations divided into costs	$9.92	$0.58	$9.56	$0.62
2. AIA designations plus all double-loaded areas at full value	9.10	0.54	9.42	0.61
3. Same as (2) above, plus overhang as one-third value	9.08	xxx	8.99	xxx

While this study is directly concerned with the net cost of comparable buildings, the total cost of each plant and its equipment proved to be a matter of interest to many visitors. The cost of site, site improvements, miscellaneous contracted services, equipment, as well as the net cost of the buildings is reported in Table III-14.

Table III-14. -- Total School Plant Costs

Item	Oak Grove	Pinellas Park
Site purchase	84,000.00	44,000.00
Site improvement		
Material and labor	32,588.20	14,972.14
Testing and vibroflotation	2,552.80	35,874.31
Miscellaneous contracted services	10,374.00	17,808.60
Equipment	78,250.22	77,967.38
Net cost of comparable buildings	699,148.97	713,850.73
Total cost of school at time of acceptance	906,914.19	914,473.16

F. Summary on Space and Costs

The ASA specifications show that the two buildings, built specifically for the research, are very similar in gross area as well as in the specific areas of instruction and administration. The only imbalance of note is that instructional space in the non-air conditioned school is about 2% larger.

The differences in areas of service, circulation and construction are considerable between schools, since these are results of building design. These differences are assumed to have little bearing on various phases of the study other than capital costs and costs of operation, which will be discussed in detail as they are presented.

The capital cost of the two school buildings differed by less than $15,000 or about 2%. The climate controlled building cost less than did the other school.

The Board of Public Instruction of Pinellas County secured two buildings which were similar in area according to the standards used in this study. On a "comparable cost" basis, the costs did not differ by an amount that would seem significant to most architects, contractors, or school officials.

CHAPTER IV

BUILDING CHARACTERISTICS AND OCCUPANCY

The orientation, design, construction and usage of a school plant are important factors in the costs of its operation. It is the purpose of this chapter to describe Oak Grove, Pinellas Park and Tyrone, the second control school, in terms of their respective orientation, design, construction and usage and to report pertinent engineering data.

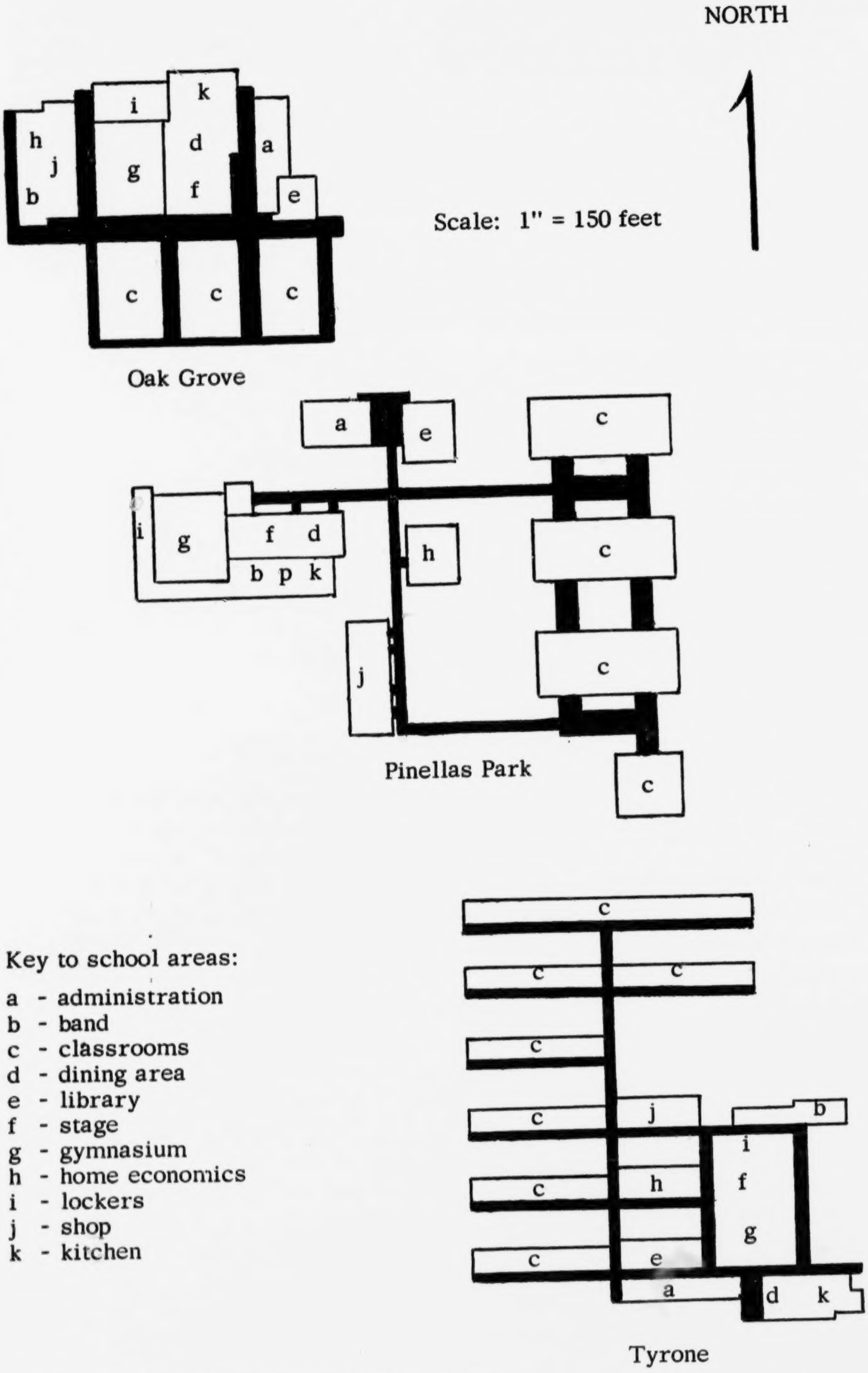
These data indicate that in many significant respects each school was fundamentally different from the other two. While there are certain reasonably close similarities, it is the considered opinion of the investigators that the differences are so great that each should be considered a separate type of plant, each equipped with its distinctive heating, cooling and plumbing systems and power supply. This implies that the elements of cost, to be presented later, likewise should be associated with the specific plant complex served. Meaningful generalizations applicable to the relative costs of operating climate-controlled and naturally ventilated schools can therefore be drawn very sparingly, if, indeed, they can be drawn at all.

A. Plant Layout and Construction

Chapter III deals with the two schools constructed specifically for the research project and deals with the school plants as they were at the time of the completed contract. Continued changes were made in these plants. Another school, Tyrone Junior High School, was added to the study and must be considered in this and subsequent chapters. Figure IV-1 presents plant layouts of each building showing the arrangement of the principal sections. Plan views of classroom sections of each of the three schools are shown in Figure IV-2.

1. Physical Orientation of the Plants as of September, 1961

Oak Grove: -- The school plant has six sections under three roofs, the sections being separated by 12-foot and 22-foot covered malls. The plant's equipment room supplies hot or chilled water for climate control. The classroom sections, gymnasium-auditorium-cafeteria, home economics rooms and shop are separated north to south by two-foot wide air chases from which fresh air is supplied to the individual room air-conditioning units. The bandroom, art room, library and administration suite receive their air from malls or outside walls.

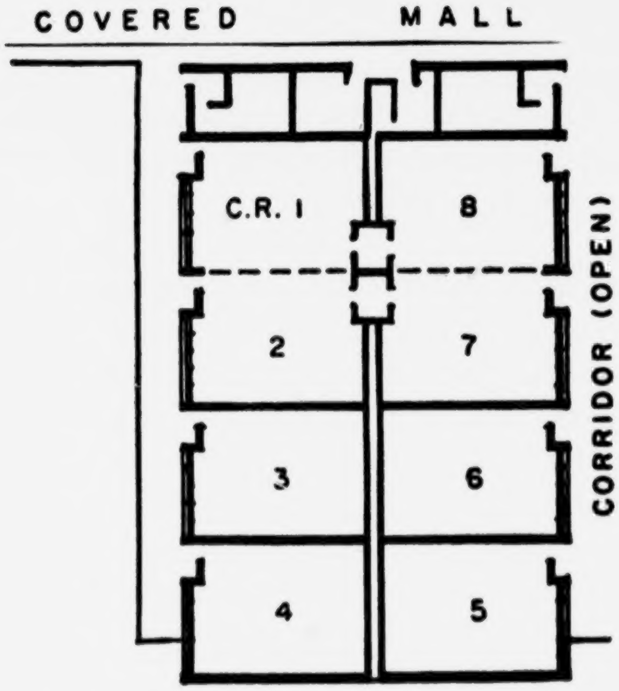

NORTH
Oak Grove
h
j
b
i
g
k
d
f
a
e
c
c
c
Pinellas Park
a
e
c
i
g
f
d
b
p
k
h
c
j
c
c
Tyrone
c
c
c
c
c
j
b
i
c
h
f
g
c
e
a
d
k

Scale: 1" = 150 feet

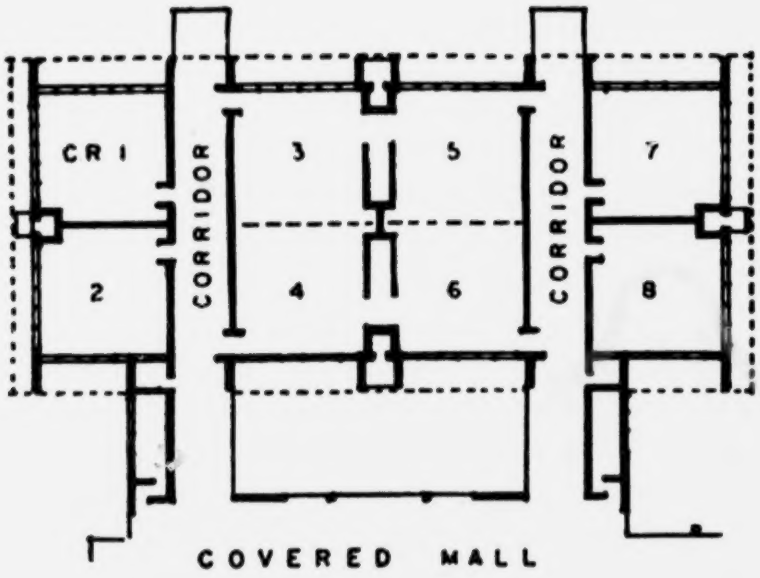
Key to school areas:

a - administration
b - band
c - classrooms
d - dining area
e - library
f - stage
g - gymnasium
h - home economics
i - lockers
j - shop
k - kitchen

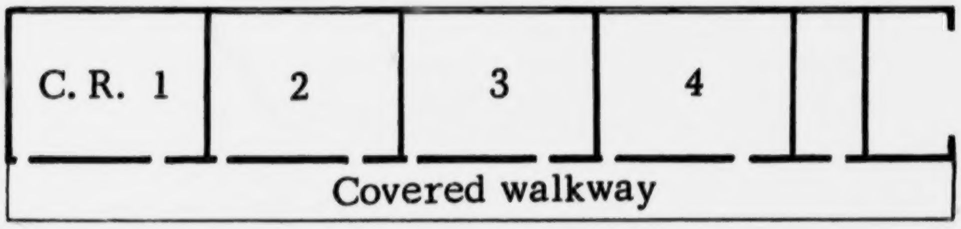
Figure IV-1. -- Plant Layout of Each School.


COVERED MALL
C.R. 1
8
2
7
3
6
4
5
CORRIDOR (OPEN)

Oak Grove Junior High School


CR 1
2
CORRIDOR
3
5
4
6
CORRIDOR
7
8
COVERED MALL

Pinellas Park Junior High School


C. R. 1
2
3
4
Covered walkway

Tyrone Junior High School

Figure IV-2. -- Plan Views of Classroom Sections of Each School

Toilets, storage, and custodial spaces have no heating or cooling. Shower rooms are heated by suspended unit heaters. The kitchen has its fresh air supply balanced with exhaust fans so the cafeteria will not be affected by the opening of doors and service windows.

The east side of the administration section has a three-foot overhang. The east wall of the east classroom section has an eight-foot roof extension supported by a full wall solar screen constructed of 4-inch concrete solar screen blocks. All west exposures are sheltered by six-foot overhangs covering walkways. North and south exposures have no overhangs or solar screening. Classrooms are three feet lower than the rest of the plant, resulting in a one-foot unenclosed horizontal opening running east and west between the classroom roof and ceiling of the main mall. Roofs overlap by three feet. The power plant building is separate and to the north of the school building.

Pinellas Park: -- The school plant has eight separate sections under eight roofs, connected by covered walkways that are eight feet wide and nine feet high. The classrooms are in pods of eight rooms each. Four of these classrooms are internal with a north or south exposure only but are so constructed that a folding door makes them into two duplex classrooms which would have both north and south exposure. Also in the pod are four outside rooms, each of which has two exposures. These pods are protected on all sides by a five-foot overhang, plus the malls that connect the pods.

Library and administration facilities are under one roof, separated by a 20-foot mall. The home economics suite and shops are each separate buildings. These three buildings are protected on all orientations by a five-foot overhang. The largest building houses cafeteria, auditorium, gymnasium, bandroom, and auxiliary rooms and is protected to some extent on its north and east sides by overhang or lobbies.

Toilets, storage, and custodial spaces have no heating. The classrooms and administration sections are heated by residential-type gas furnaces. The rest of the plant is heated by hot water from the boiler located in the cafetorium-gymnasium building.

Tyrone: -- The school plant has thirteen sections under six roofs. There are eight classroom wings with four classrooms in each. Each wing has its north walls protected by a three-foot overhang. The south walls have 10-foot covered walkways attached to the entire length of this south side. The plant is connected by 10-foot wide and 10-foot high roofed walkways. The typical classroom is 24 x 32 feet, with the longest dimension running east and west. A wing which is similar in all the above characteristics houses the shop. The rest of the plant includes a home economics suite, library, administration offices, two cafeterias, gymnatorium, boiler room, and music building, all of which are tied together by covered walkways or passageways under the equivalent of one roof.

Toilets, storage and custodial spaces have no heating. The plant is heated by hot water utilizing finned radiation or suspended unit heaters. The boiler is located at the rear of the gymnasium.

2. Construction Information as of September, 1961

Sketches of classroom wall sections typical of each of the three schools are shown in Figure IV-3. A resume follows of the type of construction and of the materials used.

Walls: The three school plants, in general, have exterior walls as follows:

> 4-inch concrete blocks with 4-inch brick veneer used on Tyrone buildings, except music building and gymnasium.
>
> 8-inch concrete blocks with 4-inch brick veneer on Tyrone music building and gymnasium; all of Pinellas Park buildings and all Oak Grove except north wall.
>
> 8-inch concrete blocks on Oak Grove north wall.

On all internal covered areas, such as malls and corridors, 8-inch concrete blocks are used. Partition walls are either 8-inch or 4-inch concrete blocks.

Floors: All three plants have 4-inch concrete slabs. These slabs in all interiors are covered with 1/16th-inch vinyl asbestos tile.

Roofs and Ceilings: Oak Grove has acoustical ceiling tile on a suspended T & T system with 4-inch mineral wool insulation batts. The roof construction consists of steel bar joists with 1/2-inch form board, gypsum deck on steel bulb tees, and built-up 5-ply roof with bitumen and gravel. Malls have the same ceiling and roof, minus the insulation batts. All roofs are flat and are on four levels.

Tyrone has a built-up roof laid on 2-inch gypsum (reinforced) poured deck on 1/2-inch sheet rock on steel joists. The ceiling has a 3-inch wool batt insulation and acoustical tile. Both roof and ceiling slope down from north to south at .0896 per foot. Some poured roof decks are 2-1/4 inch concrete on 1/2-inch form board.

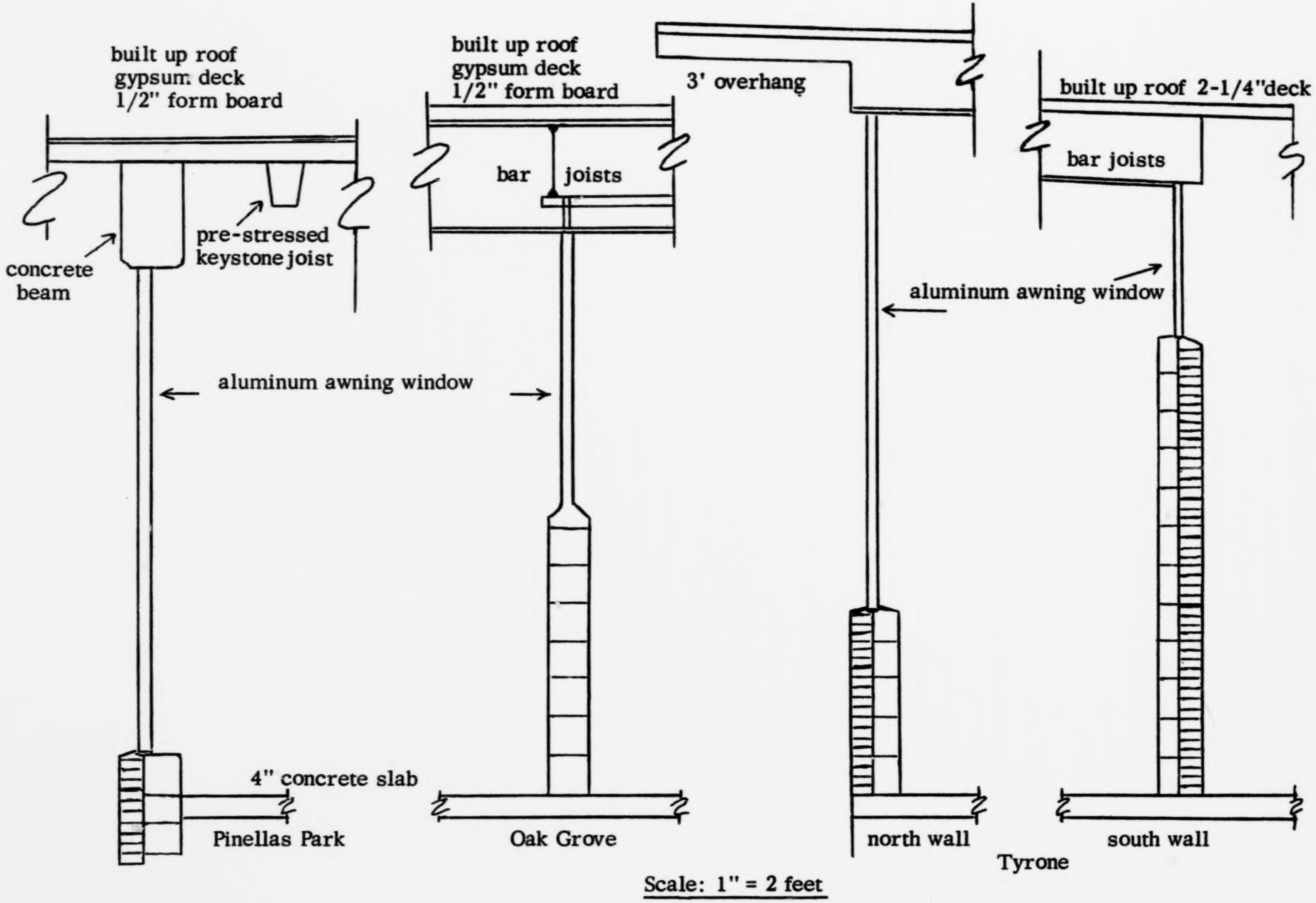

built up roof
gypsum deck
1/2" form board
concrete beam
pre-stressed keystone joist
aluminum awning window
4" concrete slab
Pinellas Park
built up roof
gypsum deck
1/2" form board
bar
joists
Oak Grove
3' overhang
built up roof 2-1/4"deck
bar joists
aluminum awning window
north wall
south wall
Tyrone
Scale: 1" = 2 feet

Figure IV-3. -- Typical Classroom Wall Sections.

Pinellas Park has exposed prestressed concrete joists with 2-inch Tectum deck and a built-up roof. All roofs are flat.

Windows: All three plants have aluminum intermediate projected-type sash or aluminum awning. Tyrone's north walls have glass from a three-foot ledge to the ceiling. Its south walls have two-foot windows along the ceiling. Pinellas Park has eight-foot high glass on all exposures with the bottom third obscure panes. Oak Grove mainly has ceiling height four-foot windows facing on malls. Specific glass orientations will be given later in this section.

Sky Domes: Tyrone has a few small skylights on hallways within its main building. Oak Grove has eighty $3\frac{1}{2}$ x $3\frac{1}{2}$ foot plexiglass sky domes in its malls. Pinellas Park has 6 x 3 foot plexiglass sky domes in the classrooms, library, and shops. In the classrooms one or two domes are used with louvers, depending on whether the rooms have one or two exposures. The domes in the hallways are without louvers. The library and shop have six and ten domes, respectively.

Classroom Lighting: All classrooms have suspended fluorescent fixtures using four-foot or eight-foot tubes, at 40 or 75 watts each.

Pinellas Park has three rows of 10 tubes each at 40 watts. Twenty of these tubes are controlled by a switch at the door. The remaining 10 tubes have a remote switch and are seldom used.

Oak Grove has three rows of eight tubes each at 40 watts. There are two switches at the door which control these three rows of lights. All lights are used when rooms are occupied.

Tyrone has two rows of six tubes each at 75 watts with a separate door switch for each row. No lights are used during most of the periods of occupancy. Occasionally one, and only one, row is used.

B. Orientation and Areas of Walls and Glass

The orientation and areas of exterior walls and glass in each of the three buildings are reported in Table IV-1. Walls and glass along halls and malls that are not completely enclosed, as well as walls along air chases, are considered to be exterior. Roof slope or differences in wall structure account for differences between the areas of opposite exposures.

Table IV-1. -- Orientation and Areas of Walls and Glass, 1961-62

Item*	Orientation	Oak Grove Area		Pinellas Park Area		Tyrone Area	
		Wall	Glass	Wall	Glass	Wall	Glass
W/O	North	4,460	321	2,070	30	1,688	152
	South	3,118	...	2,379	376	1,688	152
	East	1,798	428	1,695	336	3,556	64
	West	977	840	1,324	286	3,928	...
3'	North	...	...	...	...	11,136	7,506
	South	...	...	...	...	1,642	1,166
	East	635	795	700	300	...	...
	West	...	...	1,300	300	...	...
5'	North	...	...	3,834	4,342	...	...
	South	...	...	4,176	3,382	...	...
	East	...	...	2,488	1,122	...	...
	West	...	...	1,992	1,620	...	...
6'	West	1,458	882	...	...	...	...
10'	South	...	...	...	...	12,277	2,133
Pass	North	...	...	...	...	3,192	556
	South	...	...	...	...	2,224	116
	East	...	...	432	48	3,910	530
	West	...	...	268	32	3,598	534
Solar	East	504	360	...	...	...	...
Mall	North	1,728	...	...	...	...	...
	South	3,275	102	...	...	...	...
	East	2,798	1,546	...	...	...	...
	West	3,316	1,375	...	...	...	...
Air	East	5,560	...	...	...	...	...
	West	5,560	...	...	...	...	...
Total		35,187	6,649	22,658	12,174	48,839	12,909

*W/O = without overhang
3'= 3-foot overhang
5'= 5-foot overhang
6'= 6-foot overhang
Pass = 10-foot passageway and adj. building
Solar= 10-foot passageway and solar screen
Mall = facing on covered 12 or 22 foot malls
Air = walls of air chases

Some additional engineering notes reveal that Pinellas Park had the following estimated heating load (excluding classrooms and administration): space heating = 1,647 MBH;* 140° hot water = 750 MBH; 180° hot water booster = 120 MBH; 500 MBH for pickup and piping; making a gross load of 3,017 MBH. The space heating estimate was further broken down by separate buildings as follows:

shop	142 MBH
library	96
home economics	109
gymnasium and cafeteria complex	1,203
future expansion - these buildings	97
Total	1,647 MBH

Pinellas Park classrooms have a gas-fired furnace for every two rooms. This furnace has 100 MBH input, delivering 1,350 cfm. (cubic feet per minute).

The Pinellas Park administration building is heated by a gas-fired furnace with 200 MBH input and 160 MBH output, delivering 2,350 cfm. The engineer's estimate for this building is as follows: 26,300 cubic feet of space needing five air changes an hour would require 2,190 cfm.; fresh air intake of 438 cfm. at 40° TD would make heating demand of 103.42 MBH.

Some of the engineering estimates for Tyrone (built in 1955) show that it was originally designed as a 24-classroom plant with all the special areas that it now has. At that time the plant was to be heated by three heat pumps, producing 40 tons, on a 4-inch supply well delivering 260 gallons per minute. In these calculations the gymnasium and auditorium would have been used mainly for night activities. A listing of Tyrone's present equipment is given in Chapter V.

The engineers' estimates of the heating and cooling demands for the several areas of Oak Grove are reported in Table IV-2.

The latent heat space load for classrooms is 6.8 MBH. The sensible heat space load ranges from 22 to 28 MBH, depending on the location within the plant. Grand total heat load per classroom ranges from 37.14 to 43.14 MBH and the HTG is 24.3 to 33.2 MBH. Classroom heating is based on a 45° TD. Estimates for gymnasium use at night were for 8:00 p.m. with 13° DB temperature difference and 40.1 Gr/lb.

---

*MBH = thousands of Btu's per hour.

Table IV-2. -- Heating and Cooling Estimates at Oak Grove*

Location	Cooling MBH	Heating MBH
Drafting and shop	133.79	101.56
Band	94.38	52.59
Home economics suite	160.62	100.20
Gymnasium (nights)	611.00	-
Auditorium (days - 150 people)	172.00	89.23
Cafeteria (days - 375 people)	361.70	-
Auditorium and cafeteria (nights - 1.000 people)	713.30	342.80
Administration	251.00	220.15
East 8 classrooms	313.02	216.00
Center 16 classrooms	614.84	432.00
West 8 classrooms (future)	319.37	218.50

*Some miscellaneous rooms are not included. Certain of these data changed slightly between the time of estimates and construction. This was especially true when the additional construction sheltered the west wall.

The data in this table should be used in conjunction with the sketches, descriptive material previously presented and the more technical engineering data to be presented in the following section. From these combined sources the reader may obtain some notion of the differences among the demands placed upon the ventilating, heating and cooling equipment of these schools.

C. Design Temperature Differences and U Factors*

Only a part of the engineering estimate records will be given, yet these are sufficient for a fairly complete analysis of the buildings. From earlier sections of this report the reader can ascertain climate, building structure, and orientations and expand the information given here to answer any related questions that he may have.

The data in this section were obtained from the files of Healy, Latimer and Associates, the mechanical engineers for the three buildings. Their estimates for the cooling cycle of the air conditioning system in the buildings at Oak Grove were based on the following:

> Estimate at 3:00 p.m. for normal school operation using outside conditions of 95° Dry Bulb, 78° Wet Bulb, and a specific humidity of 116.8 Gr/lb, and room needs of 78° DB, 50% RH and 71.9 Gr/lb yield differences of 17° DB and 44.9 Gr/lb.

> The estimate used the following U factors: 12" exterior walls at .44 (Btu/hr - sq. ft. F.); 8" exterior walls at .52; partitions at .40 and .45; gymnasium and band roofs at .17; other roofs at .08; and all glass at 1.13.
>
> Equivalent resulting temperature differences were as follows: north walls and walls facing on malls at 8°; south walls at 19°; east walls at 26°; west walls at 15°; partition walls at 12°; and glass orientations at 12, 13, and 17 degrees with factors of .25 and .50, depending on the screening of solar heat.

The U factors and temperature differences given for Oak Grove may be used for similar walls and glass that have been reported for Pinellas Park and Tyrone. Those factors not given may be readily obtained from the ASHRAE Guide. Thermostats in the schools are set at 74° F., yet actual measurement in rooms shows that errors up to five degrees are not uncommon.

D. Area and Volume Changes During the Project

During the school year 1961-62 the area of Oak Grove was 61,741 square feet and the volume was 1,077,013 cubic feet. During the 1962-63 school year the school was operated with an area of 70,678 square feet and a volume of 1,214,356 cubic feet. This increase was the result of adding four classrooms, a bandroom and a fine arts room.

At Pinellas Park four classrooms were added at the end of January, 1962, so for the data representing the 1961-62 school year, this school was considered to have an average of 26 classrooms and a design enrollment of 990 for the full year. This addition increased the school plant to 68,659 square feet with a volume of 1,084,784 cubic feet. For the 1962-63 another four classrooms were added and the school operated for that year with an area of 75,441 square feet and a volume of 1,178,228 cubic feet.

Tyrone Junior High had 32 classrooms and a complement of special rooms designed for a capacity of 1,182. When this school was built in September, 1955, it contained 24 classrooms and cost $632,352.47. If this dollar cost were multiplied by the factor of general cost increase of school plants between 1955 and 1961, it would approximate

---

*U = overall coefficient of heat transmission or thermal transmission (air to air); the time rate of heat flow expressed in Btu's per hour per square feet. (ASHRAE Guide and Data Book, 1961).

the costs of the two schools built for this research project. During the 1961-62 school year this school had an area of 65,156 square feet and a volume of 1,150,092 cubic feet. For the 1962-63 school year the addition of an air conditioned teaching auditorium-cafeteria increased the area to 67,712 square feet and volume to 1,196,100 cubic feet.

E. Occupancy of the Schools

An important element in the cost of operating schools is the occupancy of the plants. An increase in the number of persons per unit area reduces the amount of heat that must be supplied on cool days and increases the amount of cooling that must be supplied on hot days. The type of usage affects the energy requirements, since regular school day usage differs considerably from that by community groups who occupy the plant for an hour or two on evenings or weekends. Occupancy data also will be related to the other phases as they are presented in this report.

At each of the three schools, a staff member maintained a daily record of the occupancy. The occupancy was classified by the type of usage: regular junior high (staff, students in classes, students in extracurricular programs); adult classes; professional educational groups; and all other community usage.

The Man-Hours-Use, MHU, was computed by multiplying the number of persons by the hours of use. Thus the occupancy by 1,000 students during a 7-hour school day yielded 7,000 MHU. The occupancy was also classified by period of usage: regular school year and summer. These data are reported in Tables IV-3 and IV-4.

The usage by school personnel and students during the regular school year may be presumed to be quite similar for all schools. Usage by community groups varied considerably both in terms of the number of events and the attendance at the events. During 1961-62 there were 75 events at Oak Grove, 55 at Pinellas Park, and 90 at Tyrone. Participation ranged from 10 to 900. The events covered activities ranging from wheelchair basketball practice to PTA meetings. During the 1962-63 year the schools were generally used for these same purposes. The community use of Oak Grove during the first academic year amounted to 2.2% of its use by school personnel, and during the second year to 2.1% of its use by school personnel. The community use at Pinellas Park during the first academic year amounted to 1.6% of its use by school personnel and to 0.8% the second. The comparable use at Tyrone was 1.7% and 0.9%. The rate of community use remained practically constant at the climate controlled school and decreased by one half at each of the others. During both summers the usage was largely accounted for by summer school at Oak Grove, church services at Oak Grove, and custodial and maintenance work at each of the three schools.

Table IV-3. -- Man-Hours-Use of Schools, 1961-62

Type of Usage	Oak Grove	Pinellas Park	Tyrone
School personnel and students (Sept. -June)	965,020	1,411,657	1,863,308
All community groups (Sept. - June)	22,034	22,588	30,996
Summer, all groups	30,480	3,320	3,960
Total --	1,017,534	1,437,565	1,898,264

Table IV-4. -- Man-Hours-Use of Schools, 1962-63

Type of Usage	Oak Grove	Pinellas Park	Tyrone
School personnel and students (Sept. -June)	1,025,131	1,528,390	1,978,546
All community groups (Sept. - June)	21,638	12,445	18,056
Summer, all groups	37,488	4,400	5,080
Total - -	1,084,257	1,545,235	2,001,682

The number of full-time equivalent students that could have been served by the MHU in each school may be computed by dividing the total MHU by 1,260, the number of hours in an academic year. The results for 1961-62 indicate that this number would have been 808 at Oak Grove, 1,141 at Pinellas Park and 1,507 at Tyrone. Also the results for the year 1962-63 would have been 861 at Oak Grove, 1,226 at Pinellas Park and 1,588 at Tyrone. It should be pointed out that per student costs computed on this basis will be systematically greater in the schools in which community use and summer school use is extensive than in those schools in which such uses are more restricted because summers and week-ends are expensive in terms of the number of people served.

The occupancy of the schools also may be compared in terms of their capacities and usage. The data in Tables IV-5 and IV-6 report eight different comparisons among the schools for each school year.

Table IV-5. -- Capacities and Usage of Schools, 1961-62

	Oak Grove	Pinellas Park	Tyrone
Number of classrooms	24	26	32
Number of special instruction rooms	5	5	5
Number of teaching stations	31	33	39
Number of professional staff	35	48	60
Design enrollment	930	990	1,170
Average daily membership	736	1,101	1,428
Average daily attendance	700	1,028	1,352
Cubage per design student	1,158	1,096	983

Table IV-6. -- Capacities and Usage of Schools, 1962-63

	Oak Grove	Pinellas Park	Tyrone
Number of classrooms	28	32	32
Number of special instruction rooms	8	6	6
Number of teaching stations	38	40	40
Number of professional staff	35	52	64
Design enrollment	1,112	1,182	1,182
Average daily membership	780	1,205	1,504
Average daily attendance	743	1,125	1,456
Cubage per design student	1,092	997	1,012

F. Summary

The data presented in this chapter give the reader information basic to all phases of the project, yet its greatest importance relates to the chapter on cost of operations.

The three plants are each of distinctive layout - campus, compact and wings. Their mechanical equipment is quite different. Their circulation patterns vary; there are differences in protection offered the occupants. The principal difference is that one school is complete in its cycle of climate control of temperature and humidity - whereas the other two depend on natural ventilation and also have less adequate control of the heating cycle. The instructional areas of the three buildings are very similar in size, lighting, and other factors having a direct bearing on learning and other student related phases of the study.

The climate controlled school has excellent insulation factors so that solar load does not penetrate the building, to any great extent, prior to the mid-afternoon dismissal of classes. The other schools' interiors react rather rapidly to solar gain and lose the heat needed on cool days equally rapidly because of their minimal insulation.

The analysis of the use of these three plants indicates that the total MHU by school personnel during the academic year was much less in Oak Grove than in either of the other schools. It also indicates that the use by community groups was proportionately greater in Oak Grove than in either of the other schools. In fact such use of the non-climate controlled buildings decreased by approximately one-half the second year but remained constant at Oak Grove. The use of Oak Grove by summer groups each year was more than seven times that of either of the other schools. The social value of the additional use of the climate controlled building may be an argument in its favor, but community and summer use adds disproportionately to the cost of its operation. This point should be considered in evaluating the comparative operating costs presented in the next chapter.

CHAPTER V

OPERATING COSTS

The authors have attempted to report the principal variables that bear on the costs of operation in the total climate control project. Since this is a field research project, the reader is cautioned to note the implication of the differences as well as the similarities of the three school plants. The investigators reported the actual facts of the operation of lights, mechanical equipment, and custodial services as they found them in the three schools involved. The researchers early noted methods of operation that could have been changed in the schools to effect economies, but the desire of the study was to observe and record school as it was normally kept. During the second year of operation there was an attempt to point out apparent economy moves.

The total project utilized data obtained during two academic years and two summer sessions. The findings upon which this report is based were derived from the operation over the period of one year, July 1, 1961, to June 30, 1962, and a second year July 1, 1962, to June 30, 1963.

A. Limitations of Cost Report

As was previously stated, this project and its reports dealt with actual field operations. Having two schools built at the same time with very similar instructional areas provided a valuable opportunity for applied research. However, all factors were not equal at the start and some tended to diverge as the research continued. The authors urge the reader to note the similarities and differences as he considers this report.

The student enrollment expanded much faster in Pinellas Park than did the enrollment at Oak Grove (the air-conditioned school). To be sure that adequate data were available, the researchers brought in Tyrone as another control school. It is a fact that the experimental school was well below design enrollment whereas the two control schools both exceeded their design enrollment.

The data reported in Chapters III and IV show that there were differences in the overall construction of the plants. There were, however, close similarities in many of the important elements of the buildings. The reports on energy sources and energy consumption are made in terms of elements, or subdivisions, of the school plants. These elements are more nearly comparable than are the total plants.

The climate records in Chapter II reveal two distinctly different winter seasons. The first winter, 1961-62, required heating in January, February and March, whereas in the 1962-63 year heating continued from October through April.

Both rate structures and types of equipment must be understood. Rate structures presented in this report show that energy and its sources varied considerably. Much goes into the making of these differences, such as storage, transportation, metering, level of demand, unit of delivery, and use of the energy as a basic or auxiliary supply.

Efficiency of equipment is also a vital factor in a study of costs. Throughout the three school plants, there are many types of energy-using equipment and these are listed in detail. Power needs and equipment usage may be inferred from the data on lighting, degree days, and occupancy. Other clues can be obtained from electrical demand data and from the "Units of Fuel."

B. Rate Structures for Utilities

The detailed cost rates of each energy source used in the three schools are presented in this section. The rates reported are those which were in effect and applicable during the period covered in this report.

The #2 fuel oil and LP gas supplied are not metered but bulk-delivered. During 1961-62 the #2 fuel oil bid was 12.34 cents per gallon but because of favorable tank car delivery prices, early shipments were received at 11.02 cents per gallon and later shipments at 11.52 cents. During 1962-63 the #2 fuel oil was obtained for 11.6 cents per gallon except for some deliveries in November and December at 10.6 and 11.4 cents.

During 1961-62 LP gas was obtained at 18 cents per gallon, whereas in 1962-63 the LP gas cost per gallon ranged from 16 to 18 cents with the major portion being purchased for 16 cents a gallon, using the following rate:

1st 500 gallons	@ .18
Next 500 gallons	@ .17
Over 1,000 gallons per month basis	@ .16

Electrical service was supplied under a commercial schedule adopted August 1, 1960. The demand charge was $15.00 for the first 10 kw, and $1.00 per kw for all over 10 kw. The energy charge was as follows: 3¢ per kwh for the first 1,000 kwh; 2¢ per kwh for the next 9,000 kwh; $1\frac{1}{2}$¢ per kwh for the next 40,000 kwh; 1¢ per kwh in excess of 50,000 kwh. The total bill is subject to a billing adjustment that varies with the cost of basic fuel at the port nearest the point at which the electricity is produced and with a United States Department of Commerce index. This billing adjustment factor has varied from $14\frac{1}{2}$% to $24\frac{1}{2}$% in recent years and has always added to consumer cost.

Since May 1, 1962, electrical service has been supplied under Rate Schedule C-1. The demand charge is $3.25 per kw for the first five kw; $1.75 per kw for the next 45 kw, and $1.25 per kw for all over 50 kw. The energy charge is as follows: First 1,000 kwh - 3.75¢ per kwh; next 9,000 kwh - 2.35¢ per kwh; next 40,000 kwh - 1.55¢ per kwh; all over 50,000 kwh - .95¢ per kwh. The billing adjustment amounted to an increase of 1.8 mills per kwh during this period.

The billing for electric service to schools receives a 5% discount when electricity is the sole energy source for the operation of all heat pump and air-conditioning systems. Also there is a 5% discount beyond each metering point when electricity is the sole source of energy for the operation of all cooking equipment.

Natural gas for the Oak Grove School was obtained through the local supplier. Meter readings obtained in thousands of cubic feet are converted to therms for billing, one therm equalling 100,000 Btu's. For present purposes, one therm is considered to be equal to 100 cubic feet of natural gas.

Prior to November 6, 1961, the old Schedule B, adopted July 20, 1959, which was called a rate for air conditioning, was in effect. Under this schedule the charges were $5.00 for the first 10 therms, $8.00 for the next 40 therms, and 8 cents a therm thereafter.

On November 6, 1961, a new Schedule B Air-Conditioning Rate was adopted and the commercial section of this rate as applied at Oak Grove for the remainder of the project is as follows:

First 10 therms or less $5.00
Next 40 therms @ 20¢ per therm
Next 950 therms @ 8¢ per therm
All over 1,000 therms @ 7¢ per therm

During the 1962-63 school year natural gas replaced LP Gas at Tyrone and the following rate structure prevailed throughout the year:

Natural Gas containing not less than 1,000 Btu per cu. ft.
First 1,000 cu. ft. used per month @ $3.92 per MCF
Next 1,000 cu. ft. used per month @ $3.02 per MCF
Next 3,000 cu. ft. used per month @ $2.02 per MCF
Over 5,000 cu. ft. used per month @ $1.52 per MCF

Starting in August, 1962, the supplier of natural gas made a Btu factor correction in all of their billings. These monthly corrections in the Btu content of each cubic foot of gas are reported in Table V-1.

Table V-1: -- Btu Factor Correction for Natural Gas Delivered after August 1, 1962

Months	Btu Factor
August	1080
September	1081
October	1080
November	1042
December	1032
January (1963)	1033
February	1034
March	1032
April	1042
May	1037
June	1038

It is apparent that the computation of any specific billing may become complicated, but the basic concern of the consumer is the average unit cost of the several forms of energy over a year of operation. The average unit cost of each form of energy was computed by dividing its respective total dollar cost by the number of units consumed. In the case of oil and gas, the average unit costs were divided by their respective Btu values and this quotient was multiplied by 100,000 to obtain the cost per 100,000 Btu's. The following tables show the cost in cents of each MBtu of energy purchased in each fuel. (One MBtu is 1,000 Btu's.) In the case of electricity the total dollar cost at each school was divided by the number of kwh consumed. The unit costs are reported in Tables V-2 and V-3.

Table V-2: -- Costs of Fuels per MBtu

Fuels	1961-62 Costs in Cents	1962-63 Costs in Cents
Natural gas for air conditioning and heating	7.9	7.8
Fuel Oil #2	8.1	8.1
LP Gas	19.4	17.8
Natural Gas for heating	-	16.0

Table V-3: -- Costs of Electricity per kwh by School

Schools	1961-62 Costs in Cents	1962-63 Costs in Cents
Oak Grove	3.09	3.05
Pinellas Park	2.91	3.00
Tyrone	3.26	3.07

C. Energy Consuming Equipment

This section of necessity is quite detailed and is included to show the differences between the schools with respect to equipment and energy demands.

1. Fuels and Energy Utilized for Specific Purposes

Natural gas and electricity were metered. Monthly records of the cost of these forms of energy were kept. The fuel oil and LPG tanks were filled in June of each year and records were kept of all subsequent fillings. The amount of fuel used during the year can be determined quite accurately.

Table V-4, which follows, indicates that three sources of energy -- gas, natural or LP; electricity; and #2 fuel oil -- were used. The table indicates the services performed by each of these fuels at the three schools. The detailed uses of the equipment are given in later sections.

Table V-4. -- Fuel Utilization for 1961-62

Service or Equipment	Oak Grove		Pinellas Park			Tyrone		
	G	E	G	O	E	G	O	E
Lighting	-	X	-	-	X	-	-	X
Science equipment	X	X	X	-	X	X	-	X
Home ec. appliances	X	X	X	-	X	X	-	X
Clinic hot water	-	X	-	-	X	-	-	X
Shop equipment	-	X	-	-	X	-	-	X
Kitchen hot water	X	-	-	X	-	X	-	-
Kitchen cooking	X	-	X	-	-	X	-	X
Kitchen baking	X	-	X	-	-	-	-	X
Kitchen refrigeration	-	X	-	-	X	-	-	X
Kitchen appliances	-	X	-	-	X	-	-	X
Kitchen water booster	-	-	X	-	-	X	-	-
Ventilation	-	X	-	-	X	-	-	X
Air conditioning	X	X*	-	-	-	-	-	-
Heating classrooms and administration	X	X*	X	-	-	-	X	-
Heating except class-rooms and admin.	X	X*	-	X	-	-	X	-
Shower water heating	X	-	-	X	-	X	-	-

Code to columns: G = Gas; O = Fuel oil; E = Electricity.
*Circulating pump, air handlers, unit motors, cooling tower fan

The 1962-63 school year fuel utilization was the same as that reported in Table V-4, except Tyrone added two gas ovens for baking and three electrical air conditioning units. Two of these are $1\frac{1}{2}$ ton units in teacher workrooms and the third is a 20-ton unit in the new teaching auditorium.

2. Equipment Using #2 Fuel Oil

Pinellas Park uses this energy source in a 2,700 MBH horizontal fire tube water boiler to produce hot water at 140^{o}. It is necessary for this boiler to operate at all times because it furnishes hot water for the kitchen and showers as well as for space heating of all areas except the administration building and classrooms. This hot water is utilized in the various suspended unit heaters, plus continuous fin radiation in the library. (Continuous fin radiation of 4-1/4 inch square aluminum fins on 1-1/4 inch copper pipe, two tiers high within convectors.)

Tyrone uses #2 fuel oil in a 2,700 MBH net boiler to produce 140^{o} hot water to space heat all areas except eight classrooms. These eight classrooms are served by hot water from an oil fired Cyclotherm. This energy source is therefore used only when space heating is required. Space heating at Tyrone uses either suspended unit heaters or continuous fin radiation.

The capacity and number of unit heaters supplied by hot water from oil fired furnaces are reported in Table V-5.

Table V-5. -- Capacities and Units of Space-Heating Equipment Supplied by Oil Fired Furnaces 1961-62

MBH Unit Heater	Unit Cfm.	Number of Units Pinellas Park	Tyrone
145	2,800	4	2
100	1,450	2	4
65	1,150	2	2
55	1,150	2	-
50	1,140	2	2
32	650	1	-
25	530	8	4
17	425	1	-

For 1962-63 Tyrone added two 100 MBH unit heaters

3. Equipment Using Natural or LP Gas

During 1961-62 Oak Grove used natural gas, while Pinellas Park and Tyrone both used LP gas. For the 1962-63 school year Tyrone was converted from LP to natural gas. All of Oak Grove's hot water for showers and kitchen use comes from its space heating boiler which must be operated at all times. The type of equipment and number of units utilizing gas during the year 1961-62 are reported in Table V-6.

4, Equipment Using Electricity

The equipment listed in detail reveals that all three schools are quite uniformly equipped in kitchens, shops and home economics suites. One exception would be noted in lighting. Oak Grove has a range of 127-143 KW, Pinellas Park 150-160 KW and Tyrone 110-111 KW. These KW's are obtained from totals of all lighting installed and do not imply that it was all in use. The KW range offered for each school indicates the change in lighting equipment from the beginning to the end of the project. Other exceptions would be in motors in parts of the school plants not previously mentioned. For this purpose at Oak Grove there are approximately 30 HP of air moving equipment motors at dispersed points and 47 HP in the equipment room. Pinellas Park has 16 HP of air moving equipment at dispersed points and 6 HP in the equipment room. Tyrone has 12 HP of air moving equipment at dispersed points and 11 HP in the equipment room.

Table V-6: -- Equipment Using Gas During 1961-62

Gas Equipment	Number of Gas Units Oak Grove	 Pinellas Park	 Tyrone
Kitchen steam kettles	2	2	2
Kitchen ranges	2	2	-
Kitchen ovens	6	6	-
Kitchen hot water booster	-	-	1
Home Economics ranges	2	2	2
Residential furnace 100 MBH	-	14	-
Residential furnace 200 MBH	-	1	-
Boiler 2,700 MBH net plus booster coil with a 6,000 MBH burner input	1	-	-
Burkay #190 hot water heater	-	-	3*
81 BHP engines	2**	-	-

*Two heaters for shower water; one for kitchen hot water. Domestic hot water was supplied at 140^{o} and boosted to 180^{o} for dishwasher use.

**Each drives a 60-ton compressor at 2,200 RPM and tower circulators.

Table V-6 remains the same for the 1962-63 year except that another 81 BHP engine was added to Oak Grove and that two kitchen ovens were added to Tyrone. Pinellas Park added two 100 MBH Residential furnaces.

During 1961-62 the connected lighting load had the following potential demand: Oak Grove 126,815 watts, Pinellas Park 150,070 watts and Tyrone 109,560 watts. The locations and wattage of lighting equipment in operation during 1961-62 are reported in Table V-7.

In addition to lighting demands, the schools had a variety of other equipment which utilized electricity. This equipment has been grouped under five headings and reported in Tables V-(8-12), titled respectively:

Oak Grove Air Handling Equipment
Exhaust Equipment Motors
Motors in Air Handlers, Unit Heaters and Unit Ventilators
Kitchen and Boiler Room Equipment
Home Economics, Shop, and Miscellaneous Electrical Equipment

The basic table in each case reports equipment in use during 1961-62 and changes in effect during 1962-63 are noted.

Table V-7. -- Location and Wattage of Lighting
1961-62

Location	Oak Grove Watts	Pinellas Park Watts	Tyrone Watts
24 classrooms	23,440	28,800	21,600
Eight classrooms	-	-	7,200
Two classrooms	-	2,400	-
Library and audio-visual	5,315	5,520	4,050
Band room	1,920	2,400	2,850
Shop and drafting	10,840	6,110	5,400
Home economics suite	5,280	4,480	5,100
Kitchen and cafeteria	10,800	7,200	6,900
Boiler, custodial, storage space	2,475	3,480	2,400
Security lights	5,400	9,600	4,200
Administration	7,525	6,580	4,910
Auditorium and stage	6,000	9,600	5,250
Gymnasium	17,200	40,000	19,800
Lobbies	300	1,800	1,500
Lockers and showers	4,320	8,000	6,400
Walkways, corridors and malls	18,400	10,100	6,000
Air chases	4,000	-	-
Classroom toilets	3,600	4,000	6,000
Total	126,815	150,070	109,560

Additions and changes to the three schools for the 1962-63 school year changed the lighting totals to: Oak Grove 142,705, Pinellas Park 159,970, and Tyrone 110,990 watts.

Table V-8. -- Oak Grove Air Handling Equipment 1961-62

Air Handling Equipment	Number of Units	Cfm.
Classrooms	24	1,250
Drawing and Sewing	2	1,500
Band and Library	4	1,500
Home Economics Suite	2	1,250
Lounge and General Office	2	750
Teacher Workroom and Principal's Office	2	500
Custodial, Guidance, Assistant Principal, Library Conference, Clinics, Home Ec. Offices	7	300
Administration Office and Library Workrooms	2	200
Gymnasium	1	17,500
Shop	1	2,900
Auditorium	1	6,000
Cafetorium	1	9,250
Shower (Suspended unit heaters)	4	530

During the 1962-63 school year Oak Grove had four additional 1,250 cfm units and three additional 1,500 cfm units.

Table V-9: -- Exhaust Equipment Motors 1961-62

Equipment	Motor HP	Number of Motors Oak Grove	Pinellas Park	Tyrone
Home economics - hoods	1/40	5	4	4
Toilets and closets	1/20	8	0	0
Paint shop	1/20	0	1	0
Paint shop, lockers, book rm.	1/8	0	0	3
Shop	1/4	0	2	0
Kitchen hood	1/4	1	1	1
Kitchen roof	1/2	1	1	3
Band and Home economics	1/2	0	4	0
Lockers	1/2	2	2	0
Corridors	1/2	0	7	0
Boiler room	1	1	0	0
Home economics and lockers	1	0	0	3
Auditorium	5	0	1	0

The data for 1962-63 was the same except Oak Grove added two 1/20 HP motors in toilets and Tyrone added one 1/2 HP motor in kitchen exhaust fan.

Table V-10. -- Motors in Air Handlers, Unit Heaters and Ventilators 1961-62

Equipment	Number of Motors Oak Grove	Pinellas Park	Tyrone
Air handlers: 7½ HP	1	-	-
5	1	-	1
2	1	-	-
1½	2	-	1
Unit heaters: 1/4 HP	-	2	4
1/2	-	4	2
1/6	-	6	2
1/15	-	2	2
26 watts	4	9	4
9 watts	-	1	-
Unit ventilators: 1/8 HP	35	-	-
70 watts	7	-	-
36 watts	2	-	-

For 1962-63 the following equipment was added: Oak Grove seven 1/8 HP unit ventilators; Tyrone two 1/2 HP unit heaters.

Table V-11. -- Kitchen and Boiler Room Electrical Equipment 1961-62

Equipment	HP	Number of Units Oak Grove	Pinellas Park	Tyrone
Kitchen:				
range		0	0	1
deep freeze		1	1	1
refrigerator		2	2	2
milk case		3	3	3
potato peeler		1	1	1
slicer		1	1	1
mixer		1	1	1
ice cream box		1	1	1
commercial ranges		-	-	2
commercial ovens		-	-	3
walk-in freezer		1	1	1
dishwasher		1	1	1
oven		0	0	1
Boiler room:				
circulator	25	1	-	-
tower fan	15	1	-	-
starter	2	2	-	-
Plant-wide:				
pumps	5	-	-	1
fuel blowers	2	-	1	-
draft inducers	$1\frac{1}{2}$	-	-	2
compressors	1	2	1	-
	3/4	-	3	1
	1/2	1	-	-
	1/3	-	-	4
	1/4	1	1	1
	1/6	-	1	1
	1/8	2	2	-
	1/12	-	-	1

In 1962-63 Oak Grove added one 2 HP starter and a shower room circulator

Table V-12. -- Home Economics, Shop, and Miscellaneous Electrical Equipment 1961-62

Equipment	HP	Number of Units Oak Grove	 Pinellas Park	 Tyrone
Home Economics:				
kitchen ranges		4	4	4
sewing machines		12	13	15
refrigerators		2	2	2
washer and dryer		1	1	1
garbage disposal		1	1	0
Shop:				
wood lathes	3/4	3	3	3
grinder	1/2	1	1	1
bandsaw	1/2	1	1	1
table saw	2	1	1	1
drill press	1/2	1	1	1
jig saw	1/2	1	1	1
sander	3/4	1	1	1
jointer	3/4	1	1	1
Miscellaneous:				
fly fans - 52"		4	6	0
water coolers		4	5	7
4000-watt hot water heater		1	1	1
3000-watt hot water heater		1	1	1
2000-watt hot water heater		0	0	1
$1\frac{1}{2}$-HP air conditioner		0	0	1
1/4 HP furnace fans		0	14	0

During 1962-63 Tyrone had an additional $1\frac{1}{2}$ HP air conditioner and a 20-ton air conditioner.

D. Operating Costs

The preceding sections have described and discussed most of the elements of the three schools that in some way relate to costs of operation. This information has been presented in detail so that engineers, architects, and school personnel will be able to note similarities and differences within the plants.

The school plants included in this study were not uniform in design, occupancy, or mechanical equipment, nor was utilization of any given power source consistent from school to school. These facts suggest that the direct comparison of individual factors of cost very probably would lead to erroneous conclusions and that overall comparisons must be qualified.

In the presentation which follows, total operating costs of the three schools for each of the two years of the study will be considered first. In the analyses, the total operating costs were divided among ten classifications, only three of which were related to energy consumption. The total costs over all classifications were related to six different unit measures to provide a basis for the comparison of the cost of operating the several schools during each of the two years of the study.

After the consideration of total operating costs, the consumption and the cost of the three forms of energy will be considered. The gross consumption and the cost of energy will be related to the six unit measures mentioned above to permit the comparison of the three schools during periods covered by this study. Because of the fact that two schools operated only 180 days and the third housed a summer school, energy consumption and cost for the nine months of academic year operation will be presented. The available metering permitted the allocation of the various types and amounts of energy consumed during the academic year among the major services. These allocations will be reported.

1. Total Operating Costs by School Years

Tables V-13 and V-14 include all costs by months of operation (except instructional) for full twelve-month years. The costs reflect the characteristics of the plants and their equipment and also the general administrative policies under which the several schools were operated. These policies include such matters as the encouragement or discouragement of community use, liberality or frugality with water for lawns, wasteful or economical use of lights, neglect or care of preventive maintenance, restricted or extensive programs of extra-curricular activities, etc.

The costs of operation were systematically greater for the year 1962-63 than for the year 1961-62. The fact that additional classrooms were operated at all three schools accounts for part of the added cost. The number of heating degree days as reported in Tables II-1 and II-2 for the years 1961-62 and 1962-63 were 512 and 820, respectively.

The cooler winter season also accounts for part of the added cost. The reduction of cooling degree days from 5241 to 4883 presumably operated to reduce the cost of cooling Oak Grove during the second year. Comparisons of costs on a monthly basis give a general impression of the relationship of climate to energy costs, but close comparisons are not justified because reported differences may have been the result of variations in billing dates and other minor factors.

Table V-13. -- Total Cost Data for Twelve Months Operation, July 1, 1961 to June 30, 1962

Months	Custodial		Maint. & Site	Water	Sewer	Garbage Disposal	Tele-phone	Gas		Fuel Oil		Electricity			Total Cost	SLADA	Net Cost
	Payroll	Supplies						Units	Cost	Gallons	Cost	KWH	Cost	Demand			
OAK GROVE																	
July	1,544.00		48.75	26.23	9.43		49.16	814	74.12			11,000	373.11	50	2,124.80	-	2,124.80
August	1,472.00	215.95	942.62	35.78	11.05		49.16	859	77.72			10,080	351.19	65	3,155.47	-	3,155.47
September	2,265.03	68.78	717.21	62.32	21.68	54.00	49.16	3,748	308.84			16,200	536.89	121	4,083.91	60.20	4,023.71
October	1,573.25	56.89	275.14	79.95	27.16	83.50	49.16	3,438	284.04			23,940	680.28	121	3,109.37	58.00	3,051.37
November	1,530.00	117.66	90.95	73.20	23.76	64.00	49.16	3,071	254.68			24,840	743.49	158	2,946.90	59.10	2,887.80
December	1,523.00	177.55	880.68	58.66	18.06	41.50	52.91	1,682	136.74			22,140	649.64	126	3,538.74	59.70	3,479.04
January	1,508.08	68.46	180.21	41.33	19.93	59.50	49.16	2,687	207.09			16,560	553.59	135	2,687.35	56.40	2,630.95
February	1,533.00	394.00	703.67	113.47	19.43	57.00	49.16	1,796	144.72			20,160	621.85	133	3,636.30	57.00	3,579.30
March	2,274.75	68.70	238.76		17.68	51.50	49.16	2,019	160.33			22,320	671.24	139	3,532.12	61.90	3,470.22
April	1,529.25	31.77	141.43		24.65	58.00	49.16	1,896	151.72			22,500	652.44	124	2,638.42	55.80	2,582.62
May	1,499.90	23.22	170.73	128.16	20.18	80.00	49.16	2,718	209.26			20,340	621.72	121	2,802.33	58.90	2,743.43
June	1,589.50	7.50	244.40	79.00	3.75		49.16	2,072	165.72			20,680	680.52	137	2,819.55	-	2,819.55
	19,841.76	1,230.48	4,634.55	698.10	216.76	549.00	593.67	26,800	2,174.98			230,760	7,135.96		37,075.26	527.00	36,548.26
PINELLAS PARK																	
July	1,533.25		122.35	18.94			43.75					15,600	400.47	26	2,118.76	-	2,118.76
August	1,509.15	234.85	1,708.06	8.94			43.75					10,800	315.97	26	3,820.72	-	3,820.72
September	2,373.05	219.21	282.55	54.96		53.50	43.75	405	72.87			1,680	90.40	40	3,190.29	70.50	3,119.79
October	1,579.00		263.25	85.89	Included	60.00	43.75	929	167.18			21,360	615.76	108	2,814.83	67.90	2,746.93
November	1,570.00	143.71	156.15	120.00	in	75.75	43.75	1,042	187.56			19,920	603.93	120	2,900.85	68.20	2,832.65
December	1,568.40	144.77	476.25	98.01	charges	44.75	43.75	904	162.76	2,912	320.86	24,720	707.63	134	3,567.18	64.30	3,502.88
January	1,570.00	180.36	38.97	53.06	for	50.00	43.75	4,355	783.87	1,189	136.97	25,680	706.44	122	3,563.42	62.80	3,500.62
February	1,583.50	71.34	491.78	76.60	water	50.50	43.75	1,947	350.46	2,420	278.78	18,240	548.78	103	3,495.49	65.30	3,430.19
March	2,382.45	153.81	351.84	96.96		59.25	43.75	1,616	290.82	777	89.51	22,320	632.62	108	4,101.01	65.80	4,035.21
April	1,553.75		154.60	100.98		61.75	43.75	1,261	227.07	730	84.10	22,080	663.22	139	2,889.22	67.30	2,821.92
May	1,584.50	71.49	294.55	94.19		81.25	43.75	874	157.24	1,475	162.55	19,440	574.67	96	3,064.19	67.00	2,997.19
June	1,571.50	21.28	339.85	90.22			43.75	-				20,640	611.17	110	2,677.77	-	2,677.77
	20,378.55	1,240.82	4,680.20	898.75		536.75	525.00	13,333	2,399.83	9,503	1,072.77	222,480	6,471.06		38,203.73	599.10	37,604.63
TYRONE																	
July	1,737.60		167.65	17.62	4.64	24.00	36.25					1,320	63.34	10	2,051.10	-	2,051.10
August	1,609.63	253.10	747.07	18.25	4.80	24.00	36.25					1,200	63.69	12	2,756.79	-	2,756.79
September	2,537.75		326.68	35.09	9.08	24.00	36.25	788	141.98			6,000	261.56	74	3,372.39	114.20	3,258.19
October	1,719.60	156.48	355.03	85.67	21.58	24.00	36.25	570	102.71			14,340	439.43	108	2,940.75	108.70	2,832.05
November	1,727.25	171.61	38.63	88.45	22.26	24.00	36.25	363	65.36			17,100	553.62	114	2,727.43	108.70	2,618.73
December	1,728.60	115.61	1,042.26	68.50	17.38	24.00	36.25	200	36.11	895	98.63	15,240	480.12	133	3,647.46	107.70	3,539.76
January	1,728.60	123.47	578.15	53.08	13.61	24.00	36.25	462	83.16	2,383	274.22	14,460	492.48	156	3,407.02	100.70	3,306.32
February	1,728.60	169.75	671.63	72.26	18.30	24.00	36.25	267	48.15	777	89.51	17,160	521.19	130	3,379.64	105.70	3,273.94
March	2,592.90	161.14	170.92	108.81	27.24	24.00	36.25	416	75.11	1,741	200.56	17,460	544.29	150	3,941.22	103.90	3,837.32
April	1,734.60	47.45	445.03	50.50	12.98	24.00	36.25	344	62.21	572	65.90	17,460	538.93	150	3,017.85	105.10	2,912.75
May	1,758.60	17.99	-80.31	82.47	20.80	24.00	36.25	217	39.20	75	17.29	13,860	434.62	85	2,350.91	105.80	2,245.11
June	1,728.60		243.75	65.93	16.75	24.00	36.25					12,330	439.16	135	2,554.44	-	2,554.44
	22,332.33	1,216.60	4,706.49	746.63	189.42	288.00	435.00	3,627	653.99	6,443	746.11	147,930	4,832.43		36,147.00	960.50	35,186.50

Table V-14. -- Total Cost Data for Twelve Months Operation, July 1, 1962 to June 30, 1963.

Months	Custodial		Maint. & Site	Water	Sewer	Garbage Disposal	Tele- phone	Gas		Fuel Oil		Electricity			Total Cost	SLADA	Net Cost
	Payroll	Supplies						Units	Cost	Gallons	Cost	KWH	Cost	Demand			
OAK GROVE																	
July	1,184.45	131.67	489.26	111.83	10.55		60.48	1,250	106.50			11,520	399.43	67	2,494.17		2,494.17
August	2,369.78	18.08	554.88		17.81		55.95	1,179	108.11			9,900	369.47	68	3,494.08		3,494.08
September	1,646.40	10.50	399.72	96.17	23.76	41.50	60.95	3,057	250.14			18,900	600.81	126	3,129.95	67.50	3,062.45
October	1,625.86	299.54			26.16	63.00	55.95	2,908	238.87			24,660	732.64	155	3,042.02	65.20	2,976.82
November	1,610.93	161.29	277.42	169.16	26.75	60.10	55.95	2,668	213.25			25,560	731.99	139	3,306.84	64.30	3,242.54
December	1,603.10	67.82	540.74		18.18	48.50	55.95	2,329	187.28			25,380	733.84	144	3,255.41	63.50	3,191.91
January	1,571.00	265.24	237.54	103.17	16.42	46.50	55.95	2,615	208.07			18,720	612.36	140	3,116.25	64.70	3,051.55
February	1,570.47	138.73	703.23		13.18	58.50	60.95	2,576	205.48			24,120	708.19	140	3,458.73	58.90	3,399.83
March	2,502.00	94.01	139.50	87.17	17.55	57.50	55.95	2,075	168.85			23,400	699.17	140	3,821.70	58.70	3,763.00
April	1,701.80	255.24	96.67		26.81	67.00	55.95	2,088	171.25			22,680	681.42	135	3,056.14	60.60	2,995.54
May	1,657.30	103.83	291.22	141.16	25.33		55.95	2,687	214.07			25,200	735.72	148	3,224.58	60.60	3,163.98
June	1,543.90	8.04	189.81	103.83			55.95	1,937	159.93			22,320	680.22	140	2,741.68		2,741.68
Total	20,586.99	1,553.99	3,919.99	812.49	222.50	442.60	685.93	27,371	2,231.80			252,360	7,685.26		38,141.55	564.00	37,577.55
PINELLAS PARK																	
July	1,224.00	307.25	331.65	7.84			52.56					11,280	452.71	113	2,376.01		2,376.01
August	2,448.00	122.90	522.84	7.36			50.36					5,040	199.26	36	3,350.72		3,350.72
September	1,642.55		190.15	35.75	Included	53.37	50.36	481	86.53			8,160	299.67	46	2,358.38	82.40	2,275.98
October	1,624.25	412.45	242.18	48.69	in	70.00	50.36	216	38.94			19,680	602.98	120	3,089.85	77.50	3,012.35
November	1,593.90	51.15	348.00	124.32	Charges	57.25	50.36	2,967	489.63	1,593	168.86	18,720	576.73	110	3,460.20	77.40	3,382.80
December	1,780.50	159.07	138.29	85.78	for	56.50	50.36	3,868	633.86	3,308	377.11	25,200	715.72	132	3,997.19	75.10	3,922.09
January	1,656.85	227.82	213.08	45.65	Water	51.00	50.36	5,005	815.77	3,093	358.68	23,520	682.90	130	4,102.11	73.70	4,028.41
February	1,673.65	97.68	649.98	84.84			50.36	2,492	413.64	560	64.96	25,200	699.49	118	3,734.60	68.70	3,665.90
March	2,510.70	173.18	451.16	93.03	24.00	65.00	50.36	3,089	509.22	2,831	328.40	30,240	815.47	137	5,020.52	69.00	4,951.52
April	1,634.55	213.24	276.76	81.39	28.00	107.75	50.36	844	148.53	1,807	209.61	25,200	715.77	127	3,465.96	70.80	3,395.16
May	1,641.35	91.04	414.27	95.66	29.50		50.36	250	45.02			21,840	669.92	142	3,037.12	70.10	2,967.02
June	1,501.90		10.48	110.41	14.75	28.00	50.36			388	45.02	22,080	653.50	122	2,414.42		2,414.42
Total	20,932.20	1,855.78	3.788.84	820.72	96.25	488.87	606.52	19,212	3,181.14	13,580	1,552.64	236,160	7,084.12		40,407.08	664.70	39,742.38
TYRONE																	
July	1,334.95	106.74	267.99	18.16	4.78	24.00	42.62					1,230	58.49	11	1,857.73		1,857.73
August	2,688.90		186.62	17.62	4.64	24.00	41.71					2,010	100.83	26	3,064.32		3,064.32
September	1,801.90	67.92	154.12	30.11	7.82	24.00	41.71	136	26.07			9,180	333.71	110	2,487.36	121.80	2,365.56
October	1,805.00	248.95	344.84	94.71	23.79	24.00	48.48	335	56.32			17,520	522.24	135	3,168.33	114.10	3,054.23
November	1,801.90		403.56	73.44	18.59	24.00	43.06	420	69.24	840	89.04	21,210	623.57	177	3,146.40	111.30	3,035.10
December	1,798.60	101.91	880.24	69.55	17.63	24.00	55.94	445	73.04	838	95.53	21,180	637.37	160	3,753.81	107.90	3,645.91
January	1,792.60	87.67	269.01	58.29	14.88	24.00	73.17	387	64.22	2,336	270.97	14,700	519.82	155	3,174.63	110.90	3,063.73
February	1,783.10	246.58	367.67	68.43	17.36	24.00	55.21	387	64.22	2,100	243.60	20,880	600.92	156	3,471.09	107.00	3,364.09
March	2,668.60	.42	315.39	80.04	20.20	24.00	55.21	517	83.98	814	94.42	21,240	620.58	168	3,962.84	104.20	3,858.64
April	1,748.70	115.83	134.31	98.60	24.75	24.00	55.21	307	52.06			17,940	534.90	136	2,788.36	107.00	2,681.36
May	1,716.60	99.56	188.14	84.35	21.26	24.00	55.21	267	45.98			20,970	609.77	159	2,844.87	105.90	2,738.97
June	1,688.00	16.09	150.90	72.95	18.47	24.00	55.21	184	33.37			17,370	528.95	142	2,587.94		2,587.94
Total	22,628.85	1,091.67	3,662.79	766.25	194.17	288.00	622.74	3,385	568.50	6,928	793.56	185,430	5,691.15		36,307.68	990.10	35,317.58

The itemized totals from Tables V-13 and V-14 have been consolidated in Tables V-15 and V-16. In each of these tables the entries for custodial payroll include compensation for both school-day and overtime services. The number of custodians regularly employed at each school was determined by a local formula in which the area of the floor surface is the most important factor. The MHU of the several plants for evening and weekend events adds to custodial cost, but the time of usage affects these entries differently. The cost of custodial supplies was based upon the orders placed and received during the year.

Table V-15. -- Total Twelve Months Costs of Operation
July 1, 1961 - June 30, 1962

Services	Oak Grove	Pinellas Park	Tyrone
Custodial payroll	$19,841.76	$20,378.55	$22,332.33
Custodial supplies	1,230.48	1,240.82	1,216.60
Maintenance and site	4,634.55	4,680.20	4,706.49
Water	698.10	898.75	746.63
Sewer	216.76	in above	189.43
Garbage disposal	549.00	536.75	288.00
Telephone	593.67	525.00	435.00
Gas	2,174.98	2,399.83	653.99[a]
Fuel oil	-	1,072.77	746.11[a]
Electricity	7,135.96	6,471.06	4,832.43[a]
Total Cost	$37,075.26	$38,203.73	$36,147.00
SLADA (deduction)[b]	527.00	599.10	960.50
Net Cost	$36,548.26	$37,604.63	$35,186.50

[a] - This substantial difference between Tyrone and the other two schools will be discussed in the summary. The reader may wish to refer to sections on construction, on occupancy, and and on fuel use and equipment.

[b] - See text - rebate for cost of school lunch utilities.

Table V-16. -- Total Twelve Months Costs of Operation
July 1, 1962 - June 30, 1963

Services	Oak Grove	Pinellas Park	Tyrone
Custodial payroll	$20,586.99	$20,932.20	$22,628.85
Custodial supplies	1,553.99	1,855.78	1,091.67
Maintenance and site	3,919.99	3,788.84	3,662.79
Water	812.49	820.72	766.25
Sewer	222.50	96.25	194.17
Garbage disposal	442.60	488.87	288.00
Telephone	685.93	606.52	622.74
Gas	2,231.80	3,181.14	568.50[a]
Fuel oil	-	1,522.64	793.56[a]
Electricity	7,685.26	7,084.12	5,691.15[a]
Total Cost	38,141.55	40,407.08	36,307.68
SLADA (deduction)[b]	564.00	664.70	990.10
Net Cost	37,577.55	39,742.38	35,317.58

[a] - This substantial difference between Tyrone and the other two schools will be discussed in the summary. The reader may wish to refer to sections on construction, on occupancy, and on fuel use and equipment.

[b] - See text - rebate for cost of school lunch facilities.

The expenditures listed under "Maintenance and Site" covered maintenance at Tyrone, since it was an older school, and site improvement at the other two schools, since minor improvements were required after the schools were occupied. The costs of establishing playing fields and other improvements of the grounds, which were properly capital improvements, have not been included. Also omitted were expenditures made to the plant while under warranty or because of initial faulty construction.

Water and sewerage costs were dependent in part upon the city or agency that supplied the service as well as upon the volumes involved. Oak Grove's billing for sewerage service is based on the quantity of water purchased.

During 1961-62 Oak Grove used 1,661,070 gallons of water, Pinellas Park 1,485,900, and Tyrone 1,589,580. During 1962-63 Oak Grove used 1,466,520 gallons, Pinellas Park 1,308,800 and Tyrone 1,432,300. These consumption figures are for the 9 months of operation during each school year.

Garbage disposal service was performed at one school under a contract with a private agency and at the other schools by city collection agencies. The costs are not strictly functions of the amount of garbage handled.

Telephone charges are based upon the number of instruments and types of service in each school.

The entries in the tables for gas, fuel oil, and electricity will be described in other tables that follow. The deduction item labeled "SLADA" is based upon school lunch average daily attendance. There is a local policy of charging off costs of school utilities to the school lunch program. This figure is obtained by finding the average monthly attendance of those students participating in the lunch program and multiplying this by 10 cents per month. (e. g., If 600 students used the lunch room daily for a month, there would be a $60 refund from the school lunch program to the general county fund, to offset utility costs.)

The twelve months figures for Oak Grove both in 1961-62 and 1962-63 include the operation of six weeks of summer school during June and July, but this program was not in operation at either Pinellas Park or Tyrone. The nine months figures for the academic year eliminate this difference.

Operational costs were analyzed in terms of costs for each of the following units: design student; student in average daily membership; cubage per design student; square foot of area; cubic foot of volume; and Man-Hour-Use. The data in Tables V-17 and V-18 report the costs in terms of these units for each school for each of the two full years of operation.

In terms of cost per design student, Oak Grove, the climate controlled school, was slightly more costly each year than was Pinellas Park. Tyrone was consistently the least costly of the three schools. In terms of average daily membership, Oak Grove proved to be approximately one and one-half times as costly as Pinellas Park and twice as costly as Tyrone. The relatively small enrollment clearly increased the cost per student served.

Table V-17. -- Twelve Months Operational Cost Expressed in Terms of Designated Units 1961-62

Units	Oak Grove	Pinellas Park	Tyrone
Design student	$39.87	$38.59	$30.89
Average daily membership	50.37	34.70	25.31
Cubage per design student	32.02	34.86	36.77
Square foot	6.00	5.56	5.55
Cubic foot	.034	.035	.031
Man-Hour-Use	.036	.026	.019

Table V-18. -- Twelve Months Operational Cost Expressed in Terms of Designated Units 1962-63

Units	Oak Grove	Pinellas Park	Tyrone
Design student	$34.30	$34.18	$30.72
Average daily membership	48.90	33.53	24.14
Cubage per design student	34.93	40.53	35.88
Square foot	5.40	5.36	5.36
Cubic foot	.031	.034	.030
Man-Hour-Use	.035	.026	.018

The cost per cubic foot per design student is a function of the "living space" allotted to each design student and of the appropriate operating cost. The entries in Tables V-17 and V-18 indicate that because the volume per design student in Oak Grove is so much greater than in the other two schools, its unit cost of service is comparable with either of the others, despite the fact that its total cost was greater. This fact suggests that within reasonable limits, climate controlled schools can be relatively spacious without adding unduly to their cost of operation.

The operating cost per square foot at Oak Grove was somewhat greater than at either of the other schools. On the basis of the cost per cubic foot of space, Pinellas Park was the most expensive; Oak Grove, second; and Tyrone, the most economical each year. In terms of the Man-Hour-Use, the order of cost was Oak Grove, Pinellas Park and Tyrone.

These data indicate that the cost per unit of ADM and MHU reflect the relatively small enrollment at Oak Grove.

A larger enrollment would no doubt decrease these unit costs. The remaining units which are functions of design and construction indicate that the differences between Oak Grove and Pinellas Park tend to be small. Tyrone operated most economically by most standards. Oak Grove was the most economical on one basis, the cubage per design student, the factor which is most highly related to the overall quality of the living space of the school.

2. Energy Usage at the Three Schools

The preceding data on total operating costs reflect the gross differences in climate, school equipment, usage, and many other factors. At this point it is necessary to isolate the data concerned with energy consumption. The data presented for twelve months will in all cases still reflect summer school sessions at Oak Grove and a year round climate controlled environment, whereas the other two schools were operated only for the regular school year of 180 days and their principal use of energy was for heating.

The data presented in the three following sets of tables categorize energy usage for the twelve months period from July 1, 1961, to June 30, 1962, and the twelve months period from July 1, 1962, to June 30, 1963. Tables V-19 and V-20, which show the actual cost of this energy, reflect usage, construction differences, rate structures, efficiency of equipment and administrative policy.

Tables V-21 and V-22 present the energy usage by units of delivery. The units of electricity usage are actual kilowatt hours, whereas the cost figures are determined by the amount used, the kilowatts of demand and an escalator clause.

Tables V-23 and V-24 present MBtu's. This is input energy in whatever form it may have been used.

Table V-19. -- Energy Cost for Twelve Months
July 1, 1961 - June 30, 1962

Energy Source	Oak Grove	Pinellas Park	Tyrone
Natural and LP Gas	$2,174.98	$2,399.83	$653.99
Fuel Oil	-	1,072.77	746.11
Electricity	7,135.96	6,471.06	4,832.43
Total Energy Costs	$9,310.94	$9,943.66	$6,232.53

Table V-20. -- Energy Cost for Twelve Months
July 1, 1962 - June 30, 1963

Energy Source	Oak Grove	Pinellas Park	Tyrone
Natural and LP Gas	$2,231.80	3,181.14	568.50
Fuel Oil	-	1,552.64	793.56
Electricity	7,685.26	7,084.12	5,691.15
Total Energy Costs	$9,917.06	11,817.90	7,053.21

Table V-21. -- Units of Energy Used for Twelve Months
July 1, 1961 - June 30, 1962

Energy Source	Oak Grove	Pinellas Park	Tyrone
Natural gas in therms	26,800	-	-
LP gas in gallons	-	13,332	3,627
Fuel oil in gallons	-	9,503	6,443
Electricity in kwh	230,760	222,840	147,930

Table V-22. -- Units of Energy Used for Twelve Months
July 1, 1962 - June 30, 1963

Energy Source	Oak Grove	Pinellas Park	Tyrone
Natural gas in 1,000's cf	27,371	-	3,385
LP gas in gallons	-	19,212	-
Fuel #2 oil in gallons	-	13,580	6,928
Electricity in kwh	252,360	236,160	185,430

Table V-23. -- MBtu's Consumed in Twelve Months
July 1, 1961 - June 30, 1962

Energy Source	Oak Grove	Pinellas Park	Tyrone
Natural and LP gas	2,680,000	1,237,209	336,586
Fuel oil	-	1,349,426	914,906
Electricity	787,353	759,102	504,737
MBtu's Consumed	3,467,353	3,345,737	1,756,229

Table V-24. -- MBtu's Consumed in Twelve Months
July 1, 1962 - June 30, 1963

Energy Source	Oak Grove	Pinellas Park	Tyrone
Natural and LP gas	2,737,100	1,782,874	338,500
Fuel oil	-	1,928,360	983,776
Electricity	861,052	805,778	632,687
MBtu's Consumed	3,598,152	4,517,012	1,954,963

Having reduced the several forms of energy used to common basic units as reported in Tables V-23 and V-24, these MBtu's were in turn expressed in designated units related to school construction and usage. Tables V-25 and V-26 show the number of MBtu's consumed in relationship to each of these designated units.

Table V-25. -- Twelve Months Energy Consumption (MBtu's) Expressed in Terms of Designated Units 1961-62

Units	Oak Grove	Pinellas Park	Tyrone
Design student	3,728 MBtu	3,380 MBtu	1,501 MBtu
Average daily membership	4,711	3,039	1,230
Cubage per design student	2,994	3,053	1,787
Square foot	56.16	48.73	26.95
Cubic foot	3.22	3.08	1.53
Man-Hour-Use	3.41	2.33	0.93

Table V-26. -- Twelve Months Energy Consumption (MBtu's) Expressed in Terms of Designated Units 1962-63

Units	Oak Grove	Pinellas Park	Tyrone
Design student	3,236 MBtu	3,821 MBtu	1,654 MBtu
Average daily membership	4,613	3.749	1,300
Cubage per design student	3,213	4,531	1,932
Square foot	50.91	59.87	28.87
Cubic foot	2.96	3.83	1.63
Man-Hour-Use	3.32	2.92	0.98

In the preceding tables the cost of energy used was separated from other elements of the total cost of operation. The energy cost was analyzed in terms of source, and the number of units delivered and units consumed were reported. These data were also related to designated units of space, volume, and usage.

3. Academic Year Operation

The operation during twelve months periods upon which the above analyses were based was not comparable for all schools because a summer school was conducted at Oak Grove but summer schools were not operated at either of the two non-climate controlled schools. To establish the energy costs during periods of comparable operation, the cost for the nine months of each academic year was computed. The total energy cost for each year for each school by type of energy is reported in Table V-27. The differences between the external climates of the two years and the assorted additions of space and equipment make comparisons between the two years somewhat inappropriate. However, the costs in each school during the second year were greater than during the first year. The most economical operation each year was that of Tyrone and the most expensive was that of Pinellas Park. The cost of operating Oak Grove, the climate controlled school, each year was intermediate between the two non-climate controlled schools.

Table V-27. -- Energy Costs of Nine Months of Operation of Each of the Three Schools by Academic Years, 1961-62 and 1962-63.

Type of Energy	September 1961 - June 1962			September 1962 - June 1963		
	Oak Grove	Pinellas Park	Tyrone	Oak Grove	Pinellas Park	Tyrone
Electricity	$5,731.14	$5,143.45	$4,266.24	$6,236.14	$5,778.65	$5,002.88
Natural Gas	1,857.42			1,857.26		535.13
LP Gas		2,399.83	653.99		3,181.14	
Fuel Oil	1,072.77	746.11			1,552.64	793.56
Total	7,588.56	8,616.05	5,666.34	8,093.40	10,512.43	6,331.57

Comparisons of the energy costs for the operation [illegible] three schools in terms of each of the previously designated units are reported in Tables V-28 and V-29 for the academic years 1961-62 and 1962-63, respectively. The rank order of the school costs based upon each and every unit did not differ between the two years. Tyrone was operated the most economically in terms of each and every unit. In terms of four of the units, the energy costs at Oak Grove were less than those of Pinellas Park. In terms of two units, Average Daily Membership and Man-Hour-Use, Pinellas Park was operated more economically than was Oak Grove. Both of these factors are obviously related to the fact that the student enrollment of Oak Grove was not as heavy in terms of space as at Pinellas Park.

Table V-28. -- Nine Months Energy Cost Expressed in Terms of Designated Units 1961-62

Units	Oak Grove	Pinellas Park	Tyrone
Design student	$8.16	$8.70	$4.84
Average daily membership	10.31	7.83	3.97
Cubage per design student	6.55	7.86	5.76
Square foot	.123	.125	.087
Cubic foot	.007	.008	.005
Man-Hour-Use	.008	.006	.003

Table V-29. -- Nine Months Energy Cost Expressed in Terms of Designated Units 1962-63

Design student	$7.37	$8.89	$5.36
Average daily membership	10.38	8.72	4.21
Cubage per design student	7.41	10.54	6.26
Square foot	.115	.140	.094
Cubic foot	.007	.009	.005
Man-Hour-Use	.008	.007	.003

The energy usage as apportioned among the several types of services in these schools is reported in Tables V-30 and V-31. The report was derived from meter readings and records of fuel delivery and the apportionment was based upon the available meters in the several schools. The cost estimates were obtained by multiplying the number of units of energy reported by the average unit cost at the several schools.

The estimates reported in these tables are consistently greater than the costs reported in the preceding sections of this chapter. This is attributable in part to the fact that billing necessarily lags behind delivery; in part to rounding errors in computing the annual average unit costs; and in part to the probable inflation of the average annual unit cost by the inclusion of the summer months in computing that average. That is, the unit rates may have been a bit too high. The total dollar differences between the academic year costs estimated on this basis and the costs derived from the billings of the several schools ranged between $430 and $956 over the two year period. In all instances these estimates are greater than the costs based upon billings.

Table V-30. -- Energy Usage for Specific Purposes and Estimated Cost for Nine Months Period, 9/5/61-6/8/62. (Groups according to available metering. Costs= metered units multiplied by average unit cost).

Units of Energy Used*			Service	Costs of Energy in Dollars		
Oak Grove	Pinellas Park	Tyrone		Oak Grove	Pinellas Park	Tyrone
5,940E	10,560E	4,620E	Security lighting - 277 evenings	184	307	151
209,680E	none	none	Air-conditioning motors	6,479	none	none
	185,520E	119,206E	Plant-wide power		5,399	3,886
			Home econ. and shop equipment			
			All lighting			
		21,584E	Kitchen refrigeration			704
			Misc. kitchen equipment			
none	none		Electric cooking and baking	none	none	
2,145N	11,029L	6,443F	Space heating of classrooms and administration	169	1,985	746
	9,503F		Space heating of cafeteria, home economics, shop, library, auditorium and gymnasium		1,073	
6,300N		1,326L**	Shower water raised to 140°	498		239
		2,301L	Kitchen hot water 140°			415
	2,304L**		Kitchen hot water boosted		415	
1,819N**			Kitchen steam kettles	144		
		none	Gas cooking and baking			none
10,848N	none		Operating compressor engines and circulating tower water	857	none	
			Total Cost	$8,331	$9,172	$6,128

*E=Electricity in kwh's; N=Natural gas in therms; L=LP Gas in gallons; F=Fuel oil in gallons.

**Also includes home economics and science gas appliances.

Table V-31. -- Energy Usage for Specific Purposes and Estimated Cost for Nine Months Period, 9/4/62-6/6/63. (Groups according to available metering. Costs= metered units multiplied by average unit cost).

Units of Energy Used*			Service	Costs of Energy in Dollars		
Oak Grove	Pinellas Park	Tyrone		Oak Grove	Pinellas Park	Tyrone
8,910E	10,560E	4,620E	Security lighting - 277 evenings	272	317	142
208,710E	none	147,540E	Air-conditioning motors	6,366	none	4,529
	205,920E		Plant-wide power		6,178	
			Home econ. and shop equipment			
			All lighting			
		26,150E	Kitchen refrigeration			803
			Misc. kitchen equipment			
none	none		Electric cooking and baking	none	none	
4,604N	16,962L	6,928F	Space heating of classrooms and administration	359	3,019	794
	13,580F		Space heating of cafeteria, home economics, shop, library, auditorium and gymnasium		1,553	
6,861N		756N**	Shower water raised to 140°	535		115
		3,083N	Kitchen hot water 140°			500
	2,250L**		Kitchen hot water boosted		401	
2,084N**			Kitchen steam kettles	163		
			Gas cooking and baking			
10,626N	none	none	Operating compressor engines and circulating tower water	829	none	none
			Total Cost	$8,523	$11,468	$6,882

*E = Electricity in kwh's; N = Natural gas in therms;
L = LP Gas in gallons; F = Fuei oil in gallons.
** Also includes home economics and science gas appliances.

E. Selected Elements in the Operation of Oak Grove

The general interest in the operation of the air conditioning equipment at Oak Grove, and in related factors at that school, caused the investigators to extend their analyses of the operations of Oak Grove beyond their study of the other schools. The instrumentation was also more adequate than that of either Pinellas Park or Tyrone. Most of the information given in this section is that for which there is no comparable data for the other schools.

Air conditioning of the classrooms at the Oak Grove School is supplied by unit ventilators located on the wall of each room and backing up to an air chase. The bandroom and library have two unit ventilators on outside walls. The offices and small rooms in the administrative suite have fan coil units on an outside wall. Other large areas such as shop, cafeteria and gymnasium have large capacity air handling units. These units supply heat to the rooms in the winter and cool them in the summer. Also, these units supply ventilation at all times and both ventilation and cooling with outside air when the outside temperatures are low enough. Thus, in winter time when the combined heating effect of the pupils' bodies, the lighting system and solar radiation is sufficient to require cooling, this ventilation cycle produces cooling without necessitating the operation of the refrigeration system. In summer, the source of refrigeration cooling is a chiller that supplies chilled water to the units for cooling purposes. In winter, this is reversed and hot water is supplied for heating. There is no mixing of air from room to room.

The 60-ton refrigeration machines were powered by internal combustion engines burning natural gas. Two such machines located in the mechanical equipment room were installed to supply chilled water during 1961-62 and the third was put on line during the year 1962-63. All of the water for heating and cooling purposes for the entire school enters and leaves the building through the two large insulated supply and return mains visible between the mechanical equipment building and the school proper. Within the building, these pipes and the branch lines serving the various parts of the building all run in accessible pipe spaces between the rooms. These spaces are also used for electric wiring and to admit outdoor air to the various heating and ventilating units throughout the school.

1. Heating and Cooling Data Related to External Conditions

The instrumentation at the Oak Grove School permitted the investigators to separate the gas input during cooling periods from the gas input during periods of heating. Unfortunately, comparable data were not directly attainable from the other two schools.

The primary function of schools is the housing of pupils during school days. The use of the buildings by teachers on days when pupils are not in attendance and week end use of buildings by custodial staffs are secondary to the principal usage. Community usage and Sunday operation for the benefit of religious congregations are services whose inclusion should not inflate the costs of operation for instructional purposes. Therefore, the treatment of heating and cooling data has been limited to the 180 days each year that school was operated with children in attendance.

Weekly temperature conditions and certain heating and cooling data for the academic years 1961-62 and 1962-63 are reported in Tables V-32 and V-33, respectively. Electrical consumption for heating, cooling and ventilating the building has not been included in these tables. The total amount of electricity consumed for heating, cooling and ventilating constitutes a small fraction of the total electrical usage. The difference between the electrical requirements for heating and cooling is negligible. The requirement for ventilating the building is less than for either of the other two cycles because, during ventilation, water is not circulated through the pipes, fuel is not blown into the boiler, and the blower fan is not operated.

For the purposes of this study, each week during which school was in session was considered as a unit of time. The first date in such weeks is the weekly designator reported in the first column of Tables V-32 and V-33. The number of school days per week is reported in the second column of the tables. The "day" used in this study is a full 24-hour day and not the abbreviated portion of the 24 hours during which the building was occupied for instructional purposes.

The arithmetic mean of the external dry-bulb readings taken at 7:30 a. m. on the days school was in session is reported as the indicator of weekly temperatures. The 7:30 a. m. reading is given because this reading was the deciding factor in whether the building should be heated, cooled, or ventilated. The daily readings varied from the weekly averages.

The data reported in Column A, 7:30 a. m. mean weekly temperatures, may be summarized and the years compared as follows:

Weekly Mean Temperatures	Frequency 1961-62	 1962-63
80-89°	-	2
70-79°	14	12
60-69°	13	11
50-59°	10	10
40-49°	1	2
30-39°	-	1

Table V-32. -- Weekly Temperature Conditions and Equipment Usage at Oak Grove for Nine Months Period - September 5, 1961 to June 8, 1962.

Week starting		School days	A	B	C	D	E	F	G
September	5	4	77	110	34	500	...	...	...
	11	5	76	115	42	500	...	...	...
	18	5	72	116	42	456	...	...	...
	25	5	72	121	42	537	...	...	...
October	2	5	70	79	42	441	...	...	...
	9	5	70	106	42	508	...	...	...
	16	5	62	47	42	279	...	...	...
	23	5	58	41	41	268	...	...	...
	30	5	57	71	42	362	...	...	...
November	6	5	61	48	37	463	4	...	...
	13	5	69	68	42	413	...	...	...
	20	3	59	12	10	75	...	...	...
	27	5	58	13	21	149	6	4	95
December	4	5	60	27	33	225	...	...	...
	11	5	69	59	42	397	...	...	...
January	2	4	48	1	4	20	40	22	
	8	5	52	3	..	...	65	37	1,520
	15	5	58	10	11	21	11	16	
	22	5	66	38	21	178	...	...	...
	29	4	51	...	..	...	28	24	
February	5	5	58	17	8	59	17	18	280
	12	5	55	17	19	147	11	10	
	19	5	69	53	38	312	...	...	...
	26	5	73	56	39	394	...	...	...
March	5	5	55	...	7	48	52	27	
	12	5	67	35	32	135	16	4	250
	19	5	65	33	34	251	7	5	
	26	5	65	28	40	199	7	...	...
April	2	5	64	17	37	196	7	...	...
	9	4	73	55	42	298	...	...	...
	16	4	60	6	22	122	11	...	...
	24	3	69	31	34	186	...	..	...
	30	5	76	82	42	406	...	...	...
May	7	5	73	69	42	398	...	...	...
	14	5	78	93	42	421	...	...	...
	21	5	80	120	42	537	...	...	...
	28	4	81	93	42	447	...	...	...
June	4	5	82	111	38	500	...	...	...
		180		2,001	1,190	10,848	272	167	2,145

A = average weekly temperature outside at 7:30 a. m.
B = cooling degree days
C = hours cooling equipment operated
D = therms used for cooling
E = heating degree days
F = hours heating equipment operated
G = therms used for heating

Table V-33. -- Weekly Temperature Conditions and Equipment Usage at Oak Grove for Nine Months Period - September 4, 1962 to June 6, 1963.

Week starting		School days	A	B	C	D	E	F	G
September	4	4	82	105	34.6	485	...	...	...
	10	5	80	148	44.4	608	...	...	...
	17	5	77	113	44.0	611	...	...	...
	24	5	73	100	42.3	553	...	...	...
October	1	5	74	112	43.2	602	...	...	...
	8	5	75	89	42.7	563	...	...	...
	16	4	73	55	37.4	406	...	...	...
	22	5	67	31	40.1	325	1	...	...
	29	5	65	27	40.4	351	...	...	...
November	5	5	61	22	32.6	269	11	6.5	109
	13	4	57	4	18.1	158	14	5.0	106
	19	3	67	31	24.8	234	...	...	...
	26	5	56	3	3.8	29	43	18.0	141
December	3	5	56	5	17.9	120	37	15.0	205
	10	5	37	...	....	...	113	39.3	675
	17	3	50	...	2.7	20	17	9.5	103
January	2	3	40	...	....	...	39	24.3	365
	7	5	50	...	4.7	31	47	31.3	490
	14	5	56	7	6.5	53	22	21.3	260
	21	4	48	...	....	...	40	17.5	393
	28	5	53	13	15.2	103	18	10.5	153
February	4	5	54	4	....	...	57	29.3	473
	11	5	53	7	7.0	51	49	25.8	393
	18	5	55	6	2.5	24	34	18.3	278
	25	5	56	3	6.3	40	37	19.5	296
March	4	5	62	28	18.3	131	15	6.3	86
	11	4	69	45	29.8	254	...	...	...
	18	5	64	46	30.0	260	16	6.0	77
	25	4	62	27	32.5	208	...	...	...
April	1	5	65	49	40.0	334	...	...	...
	8	4	68	33	34.0	259	...	...	...
	16	4	65	28	31.8	207	...	...	...
	22	5	71	69	44.0	427	...	...	...
	29	5	70	49	43.5	309	...	...	...
May	6	5	72	66	40.0	399	...	...	...
	13	5	75	91	40.0	523	...	...	...
	20	5	77	108	43.0	606	...	...	...
	27	4	76	76	32.3	498	...	...	...
June	3	5	77	108	40.0	575	...	...	...
		180		1,708	1,011.4	10,626	610	303.4	4,604

A = average weekly temperature outside at 7:30 a. m.
B = cooling degree days
C = hours cooling equipment operated
D = therms used for cooling
E = heating degree days
F = hours heating equipment operated
G = therms used for heating

It is clear that the first year was more moderate than the second in that the second year experienced a two weeks period of higher temperatures than were experienced during the first year and also experienced two more weeks of temperatures below 50° F than did the first year. Mean weekly early morning temperatures below 40° F are unusual in this area.

In 1961-62 the number of cooling degree days per week ranged from 0 - 121, with seven weeks each having more than 100 cooling degree days, eleven weeks having between 50 and 99 such days, and the remaining weeks having fewer than 50 each. Only five weeks had fewer than ten cooling degree days. The total cooling degree days were 2,001.

During 1962-63, the number of cooling degree days per week ranged from 0 - 148, with seven weeks having more than 100, six weeks having between 50 and 99, and the remaining 25 weeks having fewer than 50 each. Thirteen weeks each had fewer than 10 cooling degree days. The total number for the year was 1708, a reduction of 293 days, or approximately 15%.

The number of hours per week that the chiller was in operation is reported in Column C of these tables. During the cooler winter of 1962-63, there were more weeks of light operation than during the previous year. In terms of total usage, the hours were reduced from 1190 in 1961-62 to 1011.4 in 1962-63. This amounted to a reduction of approximately 15%.

The data reported in Column D, therms used for cooling, show a reduction from 10,848 to 10,626 or a net of 222, approximately 2%. The fact that the reduction in energy consumption was much less than the reduction in the hours of operation is due to the additional building space in use during the second year and to the increase, reported in Chapter IV, in the Man-Hour-Use. The latter amounted to approximately 6%. Thus the cooling load was greater during the second year than it had been during the first.

The last three columns of Tables V-32 and V-33 report data associated with heating. These data indicate an increase from the first to the second year of heating degree days amounting to 338, or from 272 to 610, an increase of 124%. The number of hours of operation of heating equipment increased from 167 to 303.4, or a net of 136.4 hours. The number of therms used for heating increased from 2,145 to 4,604 - a net increase of 2459 or approximately 115%. This increase is attributable to the colder winter and to the additional space to be heated.

A point of general interest is the relationship between the gas consumption required for the cooling and the gas consumption required for the heating of this building during a "typical" year. Only a first approximation is possible, and it is offered on the basis of an explanation of the method by which it was derived. The data in the preceding tables indicate that during the academic year 1961-62, 10,848 therms were used for cooling and 2,145 for heating. The ratio of consumption for cooling to that for heating was 5.06/1. During the academic year 1962-63, the consumption for cooling was 10,626 therms and for heating 4,604. The ratio was 2.31/1. The first year was unusually mild and the second unusually cool. It may be approximately correct to suggest that the "typical" year would be represented by the mean of the two years. If true, the mean of the ratios, 3.68/1, would be a reasonable estimate of the relationship between gas consumption for cooling and for heating. This, however, should be related to the demand for cooling and for heating in this climate. The relationship between the demand for heating and for cooling may be estimated by computing the ratio between cooling degree days and heating degree days each year, and averaging the two ratios, on the argument presented above. For 1961-62, the ratio 2001/272, or 7.36/1 and for 1962-63, the ratio 1701/610, or 2.79/1, express the relationships respectively, of the demand for cooling to that for heating. By averaging these ratios, it may be estimated that the need for cooling is 5.07 times as great as for heating in a typical year. The best estimate is then that in this climate in which the demand for cooling typically is about five times as great as the demand for heating, the gas consumption required for cooling this building is about 3-2/3 that required for heating. It is suggested that this apparent efficiency of the cooling operation is due in part to the fact that the mechanical equipment of this building having a ventilation cycle makes use of the external air for cooling under certain conditions but comparable use cannot be made of the external air for heating.

A limited amount of information was available about the gas consumption during summer months. During the month of July, 1962, the administrative suite and 10 rooms were used for summer school purposes and religious services were conducted in each of two rooms simultaneously on five Sundays. The total gas consumption for cooling amounted to 1165 therms. The investigators estimate that, of this amount, not more than 1000 therms were used for cooling during 21 days of school operation.

During the month of August, 1962, the administrative suite was cooled, the two rooms were used for religious services on each of four occasions, and 31 rooms were used for professional meetings of the county teachers on each of eight days. For these uses, the gas consumption was 1386 therms. Allowing an approximately proportionate amount for the religious services, it may be estimated that 1250 therms were used for educational purposes during that month.

Using 8¢ per therm as a common estimate, the cost of gas during one month of summer school operation was approximately $80.00. On the same basis, the cost of gas for educational services during the month in which the building was used principally for professional meetings was approximately $100.00.

2. Domestic Hot Water (specific for 1962-63)

At Oak Grove three sub-meters and one billing meter were used for natural gas. The sub-meters record engines 1 and 2, engine 3, and cafeteria usage. These three sub-meters added together and subtracted from the billing meter yield the total gas used in the boiler. These meters have been checked for accuracy and are well within the 2% error allowed by the Utilities Commission.

At Oak Grove the domestic water is heated in the main boiler that is primarily thought of as supplying hot water for space heating. The day by day analysis of the amount of gas consumed for boiler use allows for a very accurate calculation of the demands for domestic water heating. During 1962-63 these demands for domestic water heating were grouped for each week of the year. During September and October of 1962 when the 7:30 a.m. temperature was in the 70's, it was found that 25-30 therms a day were used for this purpose. As the temperature dropped into the 60's, there was a daily consumption of 40 therms. And the extreme usages of 50 per day were found in November and December when 7:30 temperatures were in the 30's, 40's and 50's. This demand is undoubtedly an accumulation of students taking longer and hotter showers, of line losses, of extra usage in kitchen in pre-holiday dinner food preparation, and of the fact that the boiler is on a sliding scale that increases boiler water temperature as the outside temperature drops. January and February of 1963 had an average daily usage of 40 therms to heat domestic hot water and the April, May and June daily average was 30 therms. This calculation was initially made on the basis of thousands of cubic feet of gas as recorded daily on the meter. This cubic footage was then converted to therms using the Btu factor of the gas supplied during each period. The total consumption of gas for domestic hot water during the 1962-63 school year was 6,861 therms.

3. Oak Grove Maintenance Record of Air Conditioning Equipment

The complete maintenance record to date of publication for all of the equipment needed in the air conditioning of Oak Grove is presented although the research project was involved during only a part of this time. The reason for this complete inclusion is that many visitors seem to be especially concerned with maintenance history and say that the lack of authentic information in this area makes them hesitant about installing climate control equipment.

Table V-34 gives the number of hours of operation of the chillers and the cubic feet of gas they consumed during the first 35 months of operation. Also this table lists the quantities of items used for the chilling equipment, for the water treatment and for the filtering of air in the many areas of the school.

Table V-34. -- Climate Control School Records from February 1, 1961 through December 31, 1963. Hours of Operation and Gas Consumed, Engine Items Used, Water Treatment and Filters Required.

Combined hours of operation	8,728
Gas consumed - cubic feet	3,993,200
Items Used for the Three 60-Ton Units	
Quarts of Oil used*	320
Oil Filters Used	14
Spark Plugs	66
Ignition points - sets	11
Ignition condensers	3
Corrosion inhibitors - cans added to engine water	3
STP Oil Additive - cans	14
Freon dryers used	12
Air filters for engines	5
Line and Tower Water Treatment	
Pounds of Micromet crystals for line water softener	200
Pounds of Acid treatment for scale reduction	1800
Pounds of CS for boiler and line inhibitor	200
Gallons of Bioside Control for tower fungus	20
School-wide Air Filtering	
Feet of Filter media used for 19 changes in unit ventilators	3895
Throw-away filters used in fan coil units for 12 changes	132
Air handler filters washed & reoiled twice a year	4

---

*During first year the oil usage was excessive due to crankcase leaks (caused by local alterations of drain plugs). Normal consumption is two to four quarts between changes. Oil changes at approximately 500 hour intervals have been extended to 1,000 hour intervals by use of new type oil for natural gas engines - also expecting longer life for points and plugs.

The following indicates all services to the heating and chilling equipment at Oak Grove while under warranty by the contractor. This warranty is normally one year -- the entries beyond this period are due to additional construction or equipment contracts, each of which would have a year of warranty. Therefore, the following services were accomplished on the designated dates and at no expense to the owner:

4-5-61	Replaced control on automatic three-way valve on circulating line.
5-11-61	Air compressor for controls was replaced.
5-29-61	Thermostat was replaced in A-1.
7-5-61	Replaced relay on unit.
8-4-61	Regular minor adjustment to chilling equipment.
8-22-61	Failure of safety switches on head pressure. Replaced Freon.
8-24-61	Two capacitor motors replaced after lightning storm.
8-29-61	New suction pressure gauge installed on Unit #1.
9-25-61	Checked all thermostats in classrooms.
11-14-61	Adjusted the boiler for heavy gas odor and adjusted carburetor on Unit #2.
11-22-61	Installed new thermostat in D-4, new thermometer on boiler room wall.
11-28-61	Tower fan and motor support tightened.
12-7-61	Checked on leak in tower feed and leak in engine crankcases.
12-13-61	Installed 3/8" pipe to bleed off the tower.
12-28-61	Braced tower and installed new fan couplings.
12-28-61	Installed proper regulators on all unit ventilators.
2-20-62	Replaced solenoid on Unit #2 and added Freon to Unit #1.
2-20-62	Installed a new valve for tower feed.
2-26-62	Replaced automatic feed valve on tower line.
5-21-62	Installed a new pressure regulator on compressor.
8-29-62	New relay installed in C-6 unit.
8-30-62	New relay installed in A-3 unit.
9-24-62	Periodic check on fuel regulator and timing.
10-11-62	Installed the new moisture condenser.
11-16-62	Periodic adjustment on thermostats.

11-16-62	Installed circulator pump on locker and shower room lines on additional construction.
1-29-63	Changed Unit #3 with gas and put new unit in operation.
2-26-63	Changed thermostat on unit vent in Art Room.
3-29-63	Tied in tower fan on Unit #3.
4-10-63	Replaced water pressure switch on chiller. Adjusted the chiller thermostat.
8-23-63	Installed new engine temperature gauge on Unit #3.
9-11-63	Installed new thermostat in Art Workroom fan coil unit.
9-19-63	Replaced #3 engine exhaust flange and replaced one relay and thermostat.

The following list by dates shows the services at Oak Grove paid for by the owner. These services were performed by the county school maintenance department:

2-28-61	Water tower cleaned (bottom only) of construction dirt.
3-20-61	Water tower and boiler treatment started. CS added to boiler, Micromet feeder installed.
5-27-61	Cleaned water tower from top down. Engine heat exchangers were cleaned. Tower fan and motor was greased and V belts were tightened.
11-13-61	Additional belt guard installed on engines for safety factor.
12-18-61	Exhaust flues were installed as safety factor.
12-20-61	Water tower cleaned.
5-19-62	Cleaned tower and raised sump to prevent sand from getting into suction. Cleaned Unit #1 heat exchanger and condenser. Rerolled 12 tubes in condenser.
5-22-62	Cleared Unit #2 heat exchanger and condenser. Rerolled seven tubes in condenser. Recharged Unit #1 and Unit #2.
7-28-62	Cleaned tower and engine strainers.
8-2-62	Installed kit fuel regulator on Unit #1.
9-27-62	Replaced oil return solenoid valve on Unit #1.
10-10-62	Replaced tower ladder, changed to aluminum.

12-3-62	Changed immersion heater (compressor oil) on Unit #1.
12-18-62	Installed wire screen over tower fan to keep out trash.
3-4-63	Compressor oil heater replaced on Unit #1.
3-21-63	Installed two new water pressure regulators; one for boiler feed, the other for line feed.
4-2-63	Installed belt on exhaust fan boys' locker room.
4-22-63	Air vent installed on return line from hot water storage tank.
5-6-63	Maintenance crew installed water line from Unit #3 to Micromet feeder. Replaced three corner pieces of wood on tower to stop leaks.
6-17-63	Fixed hot water leak in boiler coil.
6-27-63	Repaired air vent on main line to Administration Building. Replaced air vent on main line in boiler room.
7-3-63	Both engines: changed distributor cap, rotor, air cleaner and liquid line sight glass; replaced flange gaskets on condenser intake; rodded condenser; cleaned strainers; replaced coves in catchall; and acidized condenser and heat exchanger.
7-31-63	Repaired Freon leak at flange gasket on condenser of Unit #1.
10-18-63	Replaced belts on shop air handler.
12-3-63	Replaced V belts on two engine water pumps.
12-14-63	Cleaned engine heat exchangers.

The local school staff feels that there has been minimal maintenance on this equipment. There are examples of original faulty equipment or improper installation, and there are examples of incorrect operation or errors committed by the county staff. These examples point up the difficulties encountered by architects, engineers, control manufacturers, contractors, county maintenance personnel and the school staff when installing and operating this type of equipment for the first time. Some of the details listed in maintenance are improvements to equipment or controls as the operation became better established. Also it should be remembered that this school was a demonstration school for thousands of visitors and the maintenance and custodial services were operated at 100% of the locally defined level of quality.

4. Additional Observations and Interpretations

This analysis of energy consumption at Oak Grove, by focusing upon the consumption of gas, has understated the facts by omitting the use of electricity. The climate controlled building required electricity to operate the equipment necessary for cooling, heating and ventilating; and its design made the full use of artificial lighting necessary in all occupied working spaces. Theoretically, more electricity was used for lighting this building than would have been used if more natural light had been admitted to the classrooms.

By referring to Tables V-30 and V-31, it was determined that the cost of electrical energy at Oak Grove was $6,663 and $6,638 for the first and second year, respectively. These amounts were greater than at Pinellas Park by $957 and $143, respectively; and greater than at Tyrone by $2,022 and $1164 for the same periods. These differences average $550 per year in the case of Pinellas Park and $1593 in the case of Tyrone. When expressed as percentages of the average electrical costs, these differences amount to 9% and 31%.

The efficiency of the central boiler as a source of domestic hot water is open to question. The consumption during 1962-63 of 6,861 therms for that purpose is at the daily rate of 38.12 therms. The consumption for all cooking and baking in the cafeteria during the same year was at the rate of 11.58 therms. A system that requires more than three and one-fourth times as much energy to heat water for the cafeteria and showers as is required for baking and cooking deserves study.

The principal source of cooling was the equipment for chilling the water circulated to the rooms, but cooling was also effected by operating only the ventilating equipment on cool days. During its total operational time in 1961-62, the equipment operated 89% of the time to cool and to ventilate the building and only 11% of the time to heat it. Of the total gas energy consumed, 83% was used during periods of cooling and 17% during periods of heating. During 1962-63, the equipment operated 80% of the time to cool and to ventilate and 20% to heat the building. Of the total gas energy consumed, 70% was used during periods of cooling and 30% during periods of heating.

The maintenance record on the heating, ventilating and cooling equipment has been submitted as information, only. The investigators are unable to offer an accurate statement of cost. They cannot make comparisons with other schools because only Oak Grove has mechanical equipment of this type. Therefore, the investigators have no basis upon which to judge whether the maintenance requirements have been normal or otherwise.

F. Summary and Supplemental Discussion

The construction, equipment, occupancy and operation of each of these schools differ from that of the other schools to such extent that meaningful comparisons of cost are difficult to make. The energy consuming equipment, the types of energy used for the principal purposes, the occupancy and the hours of operation of each school have been reported in detail to enable the reader to understand each school as an entity.

Oak Grove, the climate controlled school, occupied a position in terms of net operating cost approximately midway between Tyrone and Pinellas Park, the two non-climate controlled schools. In terms of dollar cost per design student, per student in average daily membership, per square foot, and per Man-Hour-Use, the operation of Oak Grove was more expensive than either of the other schools. In terms of cubage per design student, the element stressed by technical consultants as most important, Oak Grove was the least expensive school. In terms of the cubic foot, Oak Grove was second to Pinellas Park.

The amount and cost of each type of energy consumed in each school was reported on a twelve months and on a nine months basis. In all of these comparisons except one, Oak Grove occupied an intermediate position between Pinellas Park, which was high and Tyrone,which was low. This exception was the number of MBtu's consumed in 1961-62 which was the warmer of the years and required more cooling than did the second year.

The available instrumentation made possible an analysis of the gas consumption at Oak Grove under climatic conditions requiring cooling and under conditions requiring heating. The general interest in the comparative consumption for cooling and for heating justified this extension of the study even though corresponding analyses could not be made for other schools. The amounts of gas consumed for each purpose were reported by years. The differences between the amounts were influenced by marked differences in the climatic conditions of the two years and by the addition of space the second year. It was estimated that during a "typical" year in this region, the demand for cooling would be approximately five times that for heating but the gas consumed for cooling would be only 3 2/3 that consumed for heating. The operation of the equipment on the ventilating cycle contributes to the apparent efficiency of the cooling operation.

The cost of each of two specialized types of operation was estimated. The cost of gas for the operation of about half of the climate controlled building for summer school purposes was estimated at $80 per month. The cost of gas for operating the building for the month during which there were professional pre-school meetings on eight days was estimated at $100. 00.

The gas consumed for the heating of domestic water was also a subject of study. The efficiency of the central boiler as the source of hot water is questionable.

The cost of the maintenance of the equipment at Oak Grove and its proneness to mechanical failure have been subjects of inquiry by most visiting groups. The investigators supplied the records for its first 35 months of operation. They are unable to compare this record with that of other such equipment or to evaluate the operating experience of this equipment.

The report thus far has presented in considerable detail the principal factors that contributed to the operating costs of the three schools. In addition to the information already supplied, the investigators gained certain insights, the report of which may prove interesting and valuable to the members of the professions and the general public concerned with the housing of school children and school functions and paying the costs of school operation.

The general design of a school plant no doubt should be considered in terms of its aesthetic appeal, and it certainly should be considered in terms of its capital cost and in terms of its efficiency and cost of operation. The present study has not concerned itself with aesthetic considerations. The investigators have reported that in the school system participating in this study a compact plant equipped for climate control was built as economically as an open, campus type plant without provision for controlled temperature and humidity. It became clear during the first year of operation that the compact, mechanically ventilated building could have been located on a decidedly smaller school site without impairing the program of outdoor activities. Physical education and play activities could be conducted much closer to the building without interfering with classroom instruction than was possible in the open types of buildings. The reduced window space and the practical elimination of windows opening onto the school grounds eliminated, or drastically reduced, both the visual distractions and the playground noise interference. The proximity of playing courts to dressing rooms added to the efficiency of the physical education classes procedure. Reduction of the outlying and unused space would have reduced site costs and school ground maintenance costs.

Many of the total operational costs have little or nothing to do with the design of the plant. For instance, telephone charges may be quite modest or quite large, depending upon the type of service and the type of instruments installed. School ground maintenance will vary with the frequency with which the local administration has the grass cut and the shrubbery trimmed. Costs of sewerage and garbage disposal will depend upon the services available, or obtainable, by the individual school.

These investigators are of the opinion that there are both real and imaginary differences in operating costs which are associated with building design. While an exact dollar value cannot be placed upon any of these factors, it is the considered judgment of the researchers that the compact, climate controlled building offers a real saving in each of the following respects:

A. Reduction in the man-hours of labor required to sweep open and covered walkways between buildings and police lawns adjacent to such walkways.

B. Reduction in breakage and cleaning of external, unsecured window glass.

C. Reduction in amount of fencing, security lighting and anti-vandalism devices required.

D. Reduction of time required for precision mowing of grass. (Campus style building requires much precision mowing in corners and around projections of the complex of units. This is both expensive and disturbing to classes).

E. Reduction in costs of installation and maintenance of storm drains, especially drains in open areas surrounded by building units.

F. Reduction of costs of installing and maintaining screens for insect control.

G. Reduction in repair and replacement of window operators.

H. Reduction in damage by humidity and airborne dust to equipment such as clocks, shop tools, projectors, etc.

I. Elimination of blackout curtains and venetian blinds required for audio-visual instruction.

The present investigators suspect that in these schools, as they were operated, at least one advantage that might have been claimed for the open and campus type buildings was imaginary. While the amount of daylight admitted to the classrooms was certainly greater than in the climate controlled building, the electric lights were used much, if not most, of the time.

If the costs reported for many of the services seem to be unreasonably high, or inconsistent from school to school, careless or inefficient use of the services may be suspected as a contributing factor. The rate schedules for electricity are such that 30 minutes of heavy demand results in a relatively large surcharge for the month. An understanding of the rate structure on the part of teachers and custodians and reasonable attention to the momentary demands placed on the system would undoubtedly have reduced the electrical costs reported. The consumption of fuel for the production of un-needed heat can often add to cost. In such cases, inefficient systems of automatic controls, coupled with inattention on the part of the person responsible, may be to blame. The investigators suspect that the actual costs reported are greater in some instances than would have been necessary to attain equal, or even better, service from the available equipment.

The investigators have examined a mass of detailed information about areas, volumes, equipment, occupancy, utilities, rates, wages, repairs to equipment, etc., as these were experienced in the three schools during the two years under study. Because each school is its own complex system, or, more properly, its own complex of systems, and because metering, distribution systems, equipment and services were not specific to any designated function, accurate analyses cannot be made. Nevertheless, the principal concern in this study is the cost of operating heating, ventilating, and air conditioning equipment in schools. To obtain a reasonable estimate of such costs, the investigators allowed a reasonable share of the energy input for lighting, cooking, hot water, tools, machines, etc. They then computed the cost of the remainder as the amount used for space heating, ventilating and cooling at uniform rates of 8¢ per therm and 3¢ per KWH. The resulting estimates are:

For heating and ventilating of Pinellas Park

1961-62	$1500.00
1962-63	2425.00

For heating and partial ventilating and cooling of Tyrone

1961-62	$750.00
1962-63	1350.00

For heating, ventilating and cooling of Oak Grove

1961-62	$1500.00
1962-63	1750.00

CHAPTER VI

VISITOR RATINGS OF SCHOOLS[1]

The research program provided for a comparison of Oak Grove and of Pinellas Park based upon an evaluation by competent judges. There were technical problems inherent in obtaining valid and reliable ratings in terms that would be meaningful to the members of the professions interested in the outcomes of this research project. Since analyses of the problems involved appear in the literature of educational and psychological measurement and related fields, the technical aspects of the problems will not be treated in this report. However, the solutions developed in the process of planning and executing this study will be outlined.

A. Methodology

Perhaps the most obvious problem has to do with the selection of competent judges. The problems inherent in the selection process were carefully explored and it was decided that the selections would be made from the individuals and groups who came from a distance to inspect these schools. Criteria were established for the selection. The criteria specified that judges:

a. Be professional persons such as educators, architects, and engineers.

b. Be interested in a complete tour of both schools (approximately a four-hour visit).

c. Be other than commercial representatives.

d. Be interested in many phases of the educational process. (This was intended to exclude those who were primarily interested in single aspects, such as lighting, noise, discipline, etc.)

The terms in which the buildings were to be evaluated and compared were developed through a process of study and consultation. The outline of terms, as finally accepted, follows:

---

[1] Stuart, Fred, "A Descriptive and Analytical Study of the Ratings of Two Schools Obtained Through the Use of Two Types of Rating Scales" (unpublished doctoral dissertation, Florida State University, 1963).

a. PUPIL
    1. Conduct (classrooms, halls)
    2. Physical comfort
    3. Learning environment

b. BUILDING
    1. Facility of pupil movement
    2. Ease of administration
    3. Ease of maintenance
    4. Ease of operation

c. PLANT
    1. Sound conditions
    2. Light conditions
    3. Ventilation
    4. Cleanliness

d. OTHER
    1. (Write in)
    2. (Write in)

The preceding rubrics must necessarily be converted into scale statements in terms of which the raters could make valid and reliable judgments about each building and in units of which the research staff could analyze and compare the ratings obtained. These statements must then be incorporated into a printed form that could be handled easily by the visitor-raters.

The decision to recruit the judges from among those who came of their own volition to visit the school had certain positive values. It assured a broad professional representation and a broad geographical representation. It assured interest on the part of the raters and it seemed very probable that they would try conscientiously to make as their personal contributions to the project the very best judgments of which they were capable.

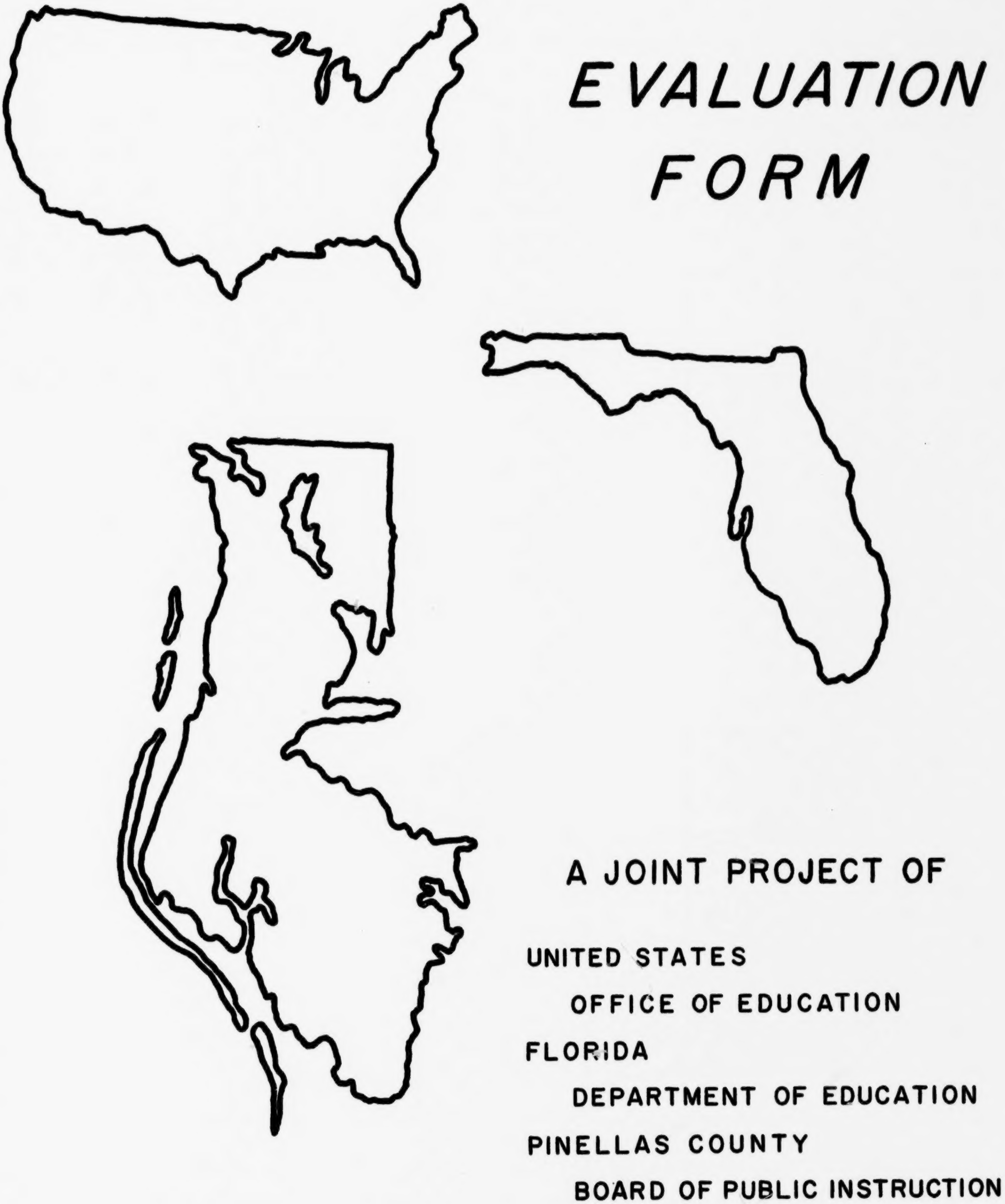
This decision also introduced problems. Because of the diversity of their backgrounds, the visitors would possess no common frame of reference. It might not be assumed that they would be equally sophisticated as judges of the class of attitude objects with which this study dealt. They would not be equally conversant with the technical vocabulary of the field, nor equally facile in handling the mechanics of the rating process. Under the conditions of their visit, they could not undergo a training program. In addition to these problems which inhered in the raters, there still remained the technical problems which inhered in scaling, *per se.*

The investigators attempted to resolve these problems, or at least to reduce their seriousness, by constructing a simple nine point scale on which each judge first rated the school best known to himself. His own rating of his own best known school then constituted a reference point for each item against which the rater judged separately each of the two schools involved in this project. That is, after judging the quality of his best known school, he had only to judge the direction and extent to which Pinellas Park differed from that school and the direction and extent to which Oak Grove differed from that same school.

The scale is shown in Figure VI-1. The scale used was in the form of single fold of heavy card stock. Its cover was designed for interest and to suggest the importance of the work in which the individual was participating. The directions for scoring the rater's best known school headed the first column when the fold was opened with the score card for that school immediately below. The directions for scoring each of the schools to be visited appeared at the top of the second column of the open booklet. The score card to be used for rating the Pinellas County schools was held in position in the column below by being inserted in die-cut corner slits. When in position, the rating card was aligned with the scale for the rater's best known school. This removable card was printed on both sides, so the rater merely turned it over after he had completed his evaluation of the first school visited. This arrangement kept each judge's ratings of his best known school constantly before him, kept the card for the comparative ratings of each school in alignment, and concealed the record of the first school while the second was being evaluated.

When members of visiting groups who met the criteria for judges reported for the standard pre-visit briefing, they were asked to participate by rating each school which they were about to visit. They were given the scale and rated their best known school while in the briefing session. At the conclusion of the tour of the first school and before leaving the grounds, the visitors recorded their comparative ratings of that school and turned their cards over. At the conclusion of the tour of the second school, and before leaving the grounds, the judges recorded their comparative ratings of that school and turned in their scale booklets.

It was anticipated that the order of visitation would influence the ratings accorded each school. Therefore visiting groups were alternated, one being taken first to Pinellas Park and then to Oak Grove and the next group being taken first to Oak Grove and then to Pinellas Park. The order of visitation was rotated systematically but the selection of persons was random because the research staff took visitors in the order in which they came.



EVALUATION FORM

A JOINT PROJECT OF

UNITED STATES
OFFICE OF EDUCATION
FLORIDA
DEPARTMENT OF EDUCATION
PINELLAS COUNTY
BOARD OF PUBLIC INSTRUCTION

Figure VI-1 - Scale Developed for Rating Buildings
(Displayed on this and the following two pages)

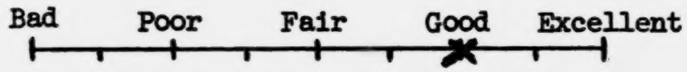
EVALUATION FORM

Cooperative Research Project No. 1067, Contract SAE 9031

Project Title:	An Evaluation of Climate Control as a Contributing Factor to an Effective Educational Program
Contracted Under:	United States Office of Education Florida State Department of Education Pinellas County Board of Public Instruction

FIRST

Select from your past experience the junior high school that you know best--that is, the one you can most clearly recall. Evaluate that school as shown on the following example. The first point is general conduct of pupils in classrooms and hallways. Place an "X" at the point on the scale that best describes this general conduct. For example, if you think their general conduct was good, you would mark the scale like this:



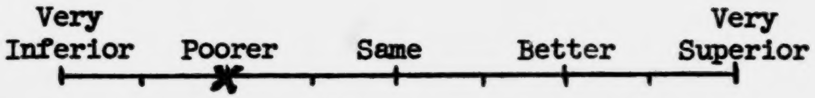
You may place your "X" on any part of the scale.

Keeping this school in mind, go ahead and rate it on each scale. To aid in keeping your best known school in mind, write its name or a fictitious name here

SECOND

On the card below, write the name of the school you will be rating. The scales on the card line up with the scales you used to rate your best known school. In terms of the ratings you selected for your best known school, evaluate this school on each scale on the card.

Place an "X" on the scale position that best describes the relationship between the general conduct in this school and the school you know best. For example, if the general conduct in this school is poorer, you would mark the scale like this:



You may place your "X" on any part of the scale. Rate this school on all the scales.

> Please do not confer with anyone. Confusion could result since comparisons are based on each rater's concept of his own best known school.

Date ____________ Time ______

School being rated ______________

Best known school ________________

		Bad	Poor	Fair	Good	Excellent	Very Inferior	Poorer	Same	Better	Very Superior
PUPIL	Conduct (classroom, halls)										
	Physical Comfort										
	Learning Environment										
BUILDING	Facility of Pupil Movement										
	Ease of Administration										
	Ease of Maintenance										
	Ease of Operation										
PLANT	Sound Conditions										
	Light Conditions										
	Ventilation										
	Cleanliness										
OTHER	____________										
	____________ (Write in)										

The process was continued until returns had been received from 25 judges who had visited Oak Grove first and from 25 judges who had visited Pinellas Park first. The score cards of members of visiting groups who did not meet the criteria for judges were discarded after their visits. All tours on which ratings were taken were conducted by the same member of the research staff.

It should be reported that the research staff developed another rating scale and used it concurrently with the one reported above. The judges marking this second instrument were drawn from the visiting groups in the manner described above, met the same criteria, alternated their visits between schools and were conducted by the same member of the research staff who conducted the tours of those judges using the first form. The results obtained through the use of both scales were subjected to a technical analysis of their qualities as measures. It was determined that the results obtained by the use of the instrument first described were technically superior to those obtained by the use of the second instrument. The evaluations reported therefore are those obtained by the use of the first instrument described. Those obtained by the use of the alternate instrument were discarded.

B. Analyses of Ratings

The fifty persons upon whose ratings this study is based came from many sections of the United States, but the majority came from the states of the southeastern part of the country. A few came from Florida, but none lived in Pinellas County or within a radius of 100 miles of the county. They reported that they were school board members, engineers, architects, supervisors, school administrators, PTA members having professional backgrounds, writers, psychologists, environmentalists or consultants.

It may be presumed that the schools best known to these judges were typical of those found in the southeast and perhaps of those found in the county as a whole. It is more probable that their best known schools were somewhat better than average than below average. Therefore the assumption that the base against which Oak Grove and Pinellas Park were rated was a typical school seems tenable and perhaps conservative.

The scale positions were assigned consecutive ordinal values of 1 - 9. The scale values of each position were:

Scale Position:	Very Inferior		Poorer		Same		Better		Very Superior
Scale Value:	1	2	3	4	5	6	7	8	9

The ratings of each school by each group of raters were converted to frequency distributions of the ratings accorded by that group. The distributions of the ratings of Oak Grove by the 25 judges who visited it prior to visiting Pinellas Park are reported in Table VI-1, and the distributions of the ratings of 25 judges who visited Oak Grove after visiting Pinellas Park are reported in Table VI-2. Similar distributions of the ratings of Pinellas Park are reported in Tables VI-3 and VI-4, respectively.

The data reported constitute two independent sets of ratings of each school. It was assumed that the order of visitation would influence the ratings awarded and the visiting groups were rotated to control for that factor. The effect of the order of visitation may be examined by comparing the median scores awarded each building by judges who visited it first with the scores awarded it by judges who had previously toured the other building. These comparisons may be made by examining Table VI-5.

The data reported constitute two independent sets of ratings of each school in the sense that each set was made by its group of judges independent of the group making the other. The first set of ratings of each school was obtained from judges who had visited that school, but not the other school. The second set of ratings of each school was obtained from judges who had completed the evaluation of the other school immediately prior to the inspection of the school under consideration. Ratings in both sets were subject to systematic error and to random error. The second rating was the sum of the true rating of the school plus or minus the basic bias of the judge, plus or minus the effect of the bias induced by the visit to the first school upon the rating of the second, plus or minus random error. Theoretically, over the 25 judges in each set, the sum of the random errors was zero. The median of the first set of ratings for each school was then considered to be the true rating, plus or minus the median bias of the judges; and the median of the second set was considered the true rating of the school, plus or minus the median bias of the judges, plus or minus the median effect of the impact of the first upon the second. Since both empirical medians were subject to error, their mean was considered the best estimate of the true rating of each building. The medians and their respective means for both sets of ratings of each building are reported in Table VI-5.

Table VI-1. -- Oak Grove Ratings - Frequency Distribution of Scaled Values Awarded by Judges Visiting Oak Grove First.

Scale Statement	Scale Values 1	2	3	4	5	6	7	8	9	Md.	Q
PUPIL -											
Conduct					3		3	8	11	8.3	.56
Physical Comfort							2	9	14	8.6	.54
Learning Environment							4	9	12	8.4	.62
BUILDING -											
Facility of Pupil Mov.					2		3	9	11	8.3	.65
Ease of Administration						3	5	6	11	8.3	.89
Ease of Maintenance						1	6	7	11	8.3	.76
Ease of Operation							4	11	10	8.3	.59
PLANT -											
Sound Conditions							6	9	10	8.2	.55
Light Conditions						2	5	10	8	8.0	.69
Ventilation						1	8	5	11	8.2	.89
Cleanliness						5	5	9	6	7.8	.86

Table VI-2. -- Oak Grove Ratings - Frequency Distribution of Scaled Values Awarded by Judges Visiting Pinellas Park First.

Scale Statement	Scale Values 1	2	3	4	5	6	7	8	9	Md.	Q
PUPIL -											
Conduct				2	3	1	3	7	9	8.0	1.12
Physical Comfort							1	5	19	8.8	.33
Learning Environment							3	4	18	8.8	.42
BUILDING -											
Facility of Pupil Mov.							3	8	14	8.6	.57
Ease of Administration					1	1	7	7	9	8.0	.85
Ease of Maintenance							4	7	14	8.6	.62
Ease of Operation						1	4	6	14	8.6	.67
PLANT -											
Sound Conditions						1	3	9	12	8.4	.62
Light Conditions						3	4	9	9	8.1	.75
Ventilation						1	6	7	11	8.3	.76
Cleanliness					1	2	4	8	10	8.2	.76

Table VI-3. -- Pinellas Park Ratings - Frequency Distribution of Scaled Values Awarded by Judges Visiting Pinellas Park First.

Scale Statement	Scale Values 1	2	3	4	5	6	7	8	9	Md.	Q
PUPIL -											
Conduct					14	4	7			5.4	.83
Physical Comfort			2	1	10	2	7	1	2	5.4	1.11
Learning Environment				2	6	3	11		3	6.6	.82
BUILDING -											
Facility of Pupil Mov.			1	1	7	1	9	1	5	6.8	1.18
Ease of Administration			1	2	8	5	7	1	1	5.8	.99
Ease of Maintenance				2	5	1	12	1	4	6.9	1.03
Ease of Operation				1	8	3	10	1	2	6.5	.97
PLANT -											
Sound Conditions			1	2	6	3	9	1	3	6.6	1.11
Light Conditions			1	1	8	2	11	1	1	6.5	1.04
Ventilation			4	2	3	3	10	2	1	6.5	1.30
Cleanliness			2	3	9	3	3	1	4	5.3	1.22

Table VI-4. -- Pinellas Park Ratings - Frequency Distribution of Scaled Values Awarded by Judges Visiting Oak Grove First.

Scale Statement	Scale Values 1	2	3	4	5	6	7	8	9	Md.	Q
PUPIL -											
Conduct			2	2	8	6	5	2		5.6	.94
Physical Comfort		2	2	3	11	3	6			5.2	.75
Learning Environment		2		4	8	3	8			5.3	1.09
BUILDING -											
Facility of Pupil Mov.			3	3	7	1	8	2	1	5.4	1.28
Ease of Administration			3	1	13	1	5	2		5.2	.99
Ease of Maintenance		1		6	4	5	8	1		5.8	1.23
Ease of Operation		1		5	7	6	5	1		5.4	.96
PLANT -											
Sound Conditions	1	1	1	4	8	7	2	1		5.2	.87
Light Conditions		2	4	4	4	3	7	1		5.1	1.60
Ventilation	1		4	6	7	4	3			4.7	.99
Cleanliness		2	2	8	7	5	1			4.6	.74

Table VI-5. -- Medians of the Two Sets of Ratings of Pinellas Park and of Oak Grove and Their Respective Means.

	Pinellas Park			Oak Grove		
	Order of visitation			Order of visitation		
Scale Statement	1	2	Mean	1	2	Mean
PUPIL -						
Conduct	5.4	5.6	5.50	8.3	8.0	8.15
Physical Comfort	5.4	5.2	5.30	8.6	8.8	8.70
Learning Environment	6.6	5.3	5.95	8.4	8.8	8.60
BUILDING -						
Facility of Pupil Mov.	6.8	5.4	6.20	8.3	8.6	8.45
Ease of Administration	5.8	5.2	5.50	8.3	8.0	8.15
Ease of Maintenance	6.9	5.8	6.35	8.3	8.6	8.45
Ease of Operation	6.5	5.4	5.95	8.3	8.6	8.45
PLANT -						
Sound Conditions	6.6	5.2	5.90	8.2	8.4	8.30
Light Conditions	6.5	5.1	5.80	8.0	8.1	8.05
Ventilation	6.5	4.7	5.60	8.2	8.3	8.25
Cleanliness	5.3	4.6	4.95	7.8	8.2	8.00

The reader will recall that these were comparative ratings on a nine-point scale with the judges' "best known" school. The median of the judges' best known schools probably was typical of the schools in the southeastern United States or possibly in a much larger segment of the country. It was somewhat more likely to have been a better-than-average than a below-average school. In the scaling system employed, the median of the judges' best known schools was automatically rated at 5, because a rating of one of these schools as the "same" was assigned a scale value of 5. The mean scale values of each statement for Pinellas Park, for Oak Grove and for the typical school are the basis of the graphical presentation of the relative positions of these schools presented in Figure VI-2.

Pinellas Park is depicted in this figure as a good, typical school. Its best features were judged to be its facility of pupil movement and ease of maintenance. Its broad covered walkways and single-loaded corridors and wide malls were designed to make it easy for pupils to move from place to place in a quick and orderly manner. The floor covering, wall finishes, hardware, and accessibility of the basic equipment contribute to the ease of maintenance of this building. General cleanliness was judged to be the weakest aspect of this plant. Granting the accuracy of the judgment that the general cleanliness of this plant was not on a par with its other characteristics, the investigators suggest that among the underlying reasons may be the fact that the building and the grounds adjacent to it are extensive and open to wind-blown dust and debris. Maintaining a high standard of cleanliness in this plant may require attention and labor beyond that required in one that is more compact.

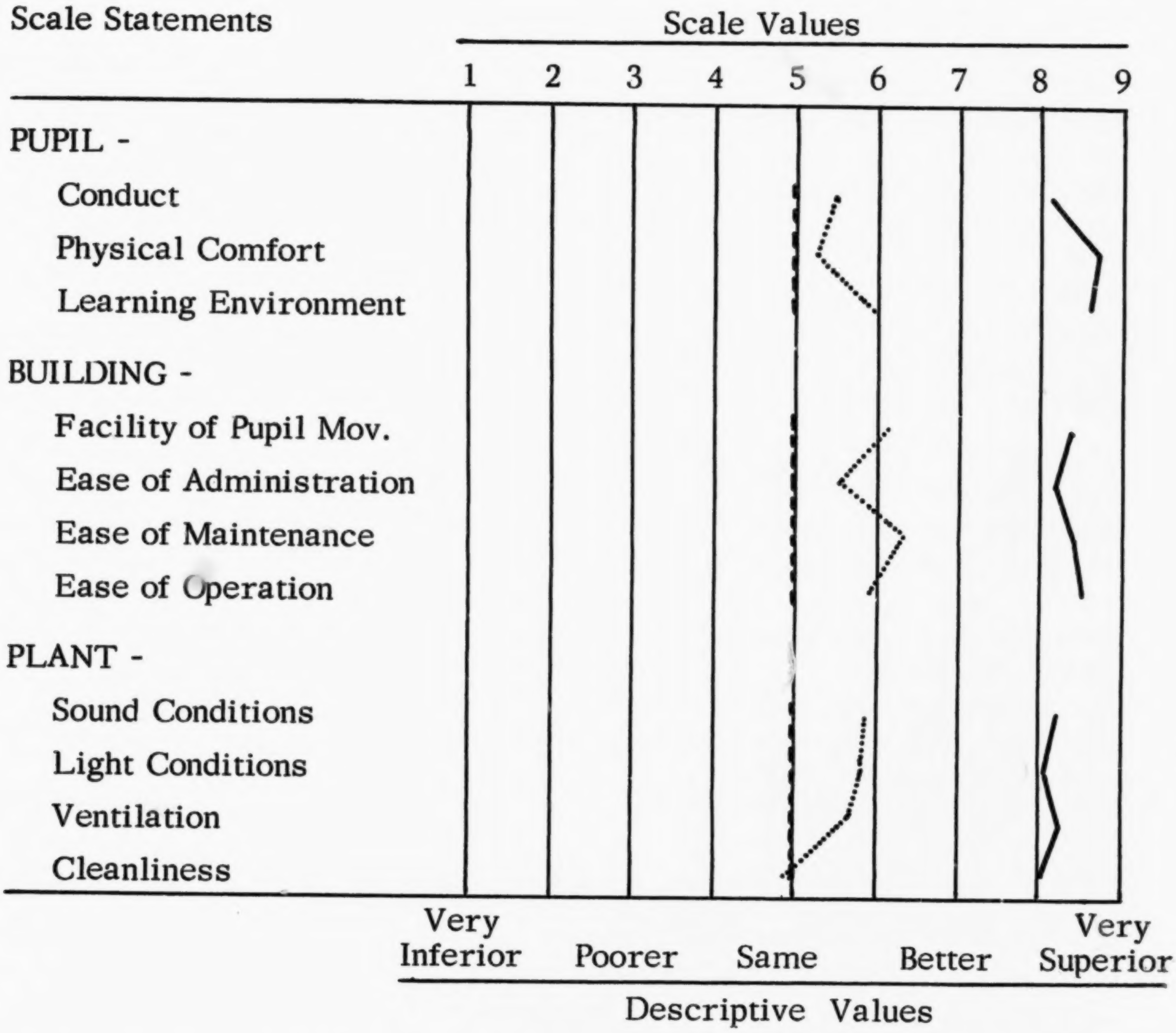


Figure VI-2. -- Relative Scale Positions of Pinellas Park, of Oak Grove and of Rater's Typical School in Terms of Each Scale Statement.

Pinellas Park ·········· Oak Grove ———— Typical School - - - - - -

Oak Grove is depicted in Figure VI-2 as a superior school. In all respects except facility of pupil movement and ease of administration, it is separated from Pinellas Park by the whole category of schools that the judges considered "better" than their best known, but not the best of schools. The consistency of the ratings over all scale statements is a more important characteristic of the evaluation than are the differences among the statements. These differences are notably less than was true for Pinellas Park.

The initial purpose in rotating the order of visitation was to control for the impact of one school upon the ratings accorded the other. In the process of analyzing the data, the investigators developed the highly tentative theory that the ratings on the several scale statements applied to the second school would be differentially affected by differences among the impacts upon the judges of the several aspects of the first school. That is, a set of judges who had observed a phenomenon in their first school that was strikingly different from that which they had been accustomed to would carry this experience over to their second school. At this second school they would respond to the related scale item in a manner different from that of the set of judges who had not had that experience because they had not yet visited the school in which the strikingly different phenomenon existed. It follows then that those scale statements on which the evaluations of the two sets of judges differed significantly with respect to one building are indicators of the striking characteristics of the other building.

To explore this theory, the data in Table VI-6 were prepared. There are reported under the headings of order 1, the medians and the quartile deviations of the scores awarded by the set of judges visiting each building first and under order 2 the same statistics for the judges visiting each school after they had been to the other. The differences obtained by subtracting from the median scores of the first set of judges the median scores of the second set of judges are reported in the difference columns. The positive sign, understood in each case, indicates that judges visiting the school first awarded higher ratings than did the judges visiting it second. The negative sign indicates that the second set of judges awarded the higher ratings.

The set of judges who visited Pinellas Park first awarded higher ratings on 10 of the 11 items than did the second set of judges. They also awarded higher ratings on 9 of the 11 items at Oak Grove. It is possible that this set of judges was more generous than was the set who visited Oak Grove first. If so, they were generally more generous at Pinellas Park than at Oak Grove, or the brevity of the nine-point scale hampered their expression of generosity at Oak Grove. The possibility of a difference between the two sets of judges is real and should be considered a limitation upon the following results.

Table VI-6. -- Comparison of Ratings by Order of Visitation.

Scale Statement	Pinellas Park						Oak Grove					
	Order of visitation						Order of visitation					
	1		2		Diff. (1-2)	Stan. Diff.	1		2		Diff. (1-2)	Stan. Diff.
	Md	Q	Md	Q			Md	Q	Md	Q		
PUPIL -												
Conduct	5.4	.83	5.6	.94	-0.2	0.45	8.3	.56	8.0	1.12	0.3	0.65
Physical Comfort	5.4	1.11	5.2	.75	0.2	0.40	8.6	.54	8.8	.33	-0.2	0.85
Learning Environment	6.6	.82	5.3	1.09	1.3	2.56	8.4	.62	8.8	.42	-0.4	1.44
BUILDING -												
Facility of Pupil Mov.	6.8	1.18	5.4	1.28	1.4	2.16	8.3	.65	8.6	.57	-0.3	0.93
Ease of Administration	5.8	.99	5.2	.99	0.6	1.15	8.3	.89	8.0	.85	0.3	0.66
Ease of Maintenance	6.9	1.03	5.8	1.23	1.1	1.85	8.3	.76	8.6	.62	-0.3	0.82
Ease of Operation	6.5	.97	5.4	.96	1.1	2.17	8.3	.59	8.6	.67	-0.3	0.91
PLANT -												
Sound Conditions	6.6	1.11	5.2	.87	1.4	2.67	8.2	.55	8.4	.62	-0.2	0.65
Light Conditions	6.5	1.04	5.1	1.60	1.4	1.97	8.0	.69	8.1	.75	-0.1	0.26
Ventilation	6.5	1.30	4.7	.99	1.8	2.97	8.2	.89	8.3	.76	-0.1	0.23
Cleanliness	5.3	1.22	4.6	.74	0.7	1.32	7.8	.86	8.2	.76	-0.4	0.94

The standard error of the difference was computed between each pair of median ratings pertaining to each school. The standard errors were considered standard units of measure and divided into the obtained differences. The results obtained were expressions, in standard units, of the magnitudes of the differences between median ratings by the two sets of judges. The differences in units of their respective standard errors are reported in the columns entitled Standard Differences. The standard differences were arbitrarily placed in three groups: those 2. 67 and greater; those between 2. 02 and 2. 66, and those smaller than 2. 02. The first group contained Ventilation (2. 97) and Sound Conditions (2. 67) at Pinellas Park. The second group included Learning Environment (2. 56), Ease of Operation (2. 17) and Facility of Pupil Movement (2. 16), all being at Pinellas Park. The remaining six differences between the ratings of Pinellas Park and all differences between the ratings at Oak Grove are less than 2. 02 and hence were included in the third group.

In keeping with the highly tentative theory outlined above, the investigators suggest that the group of judges who visited Oak Grove first were so impressed by the quality of the ventilation and the sound conditions and possibly with the learning environment, ease of operation and ease of maintenance at that school that they down-graded these aspects of Pinellas Park relative to the appraisals made by the other judges who had not first observed Oak Grove. None of the remaining aspects of Oak Grove and no aspect of Pinellas Park exerted as significant an effect upon the judges. It is therefore suggested that the outstanding characteristics of the climate controlled school may be its ventilation and sound conditions, and possibly its learning environment, ease of operation, and facility of pupil movement.

In conclusion, the ratings of these schools by judges selected on the basis of their presumed knowledge and interest from the groups of visitors indicated that Pinellas Park was a good, typical school. The ratings indicated that Oak Grove by the same standards was a superior school. The inference that Oak Grove possessed five characteristics which raised the judge's standards to such an extent that their appraisal of Pinellas Park was adversely affected and that Pinellas Park possessed no characteristics which materially affected the judge's standards, should be only tentatively accepted.

CHAPTER VII

THE COMFORT LEVELS REPORTED BY STUDENTS

One of the basic purposes of the study of the climate controlled and non-climate controlled schools was to determine the levels of student comfort in each type of plant. Two aspects of comfort were of particular concern. To those responsible for the making of administrative decisions about the building of schools, the important considerations were the relationships between comfort and the temperatures of classrooms which under normal operating conditions were attainable with, and without, air conditioning in this general geographic area. These administrators stated that they needed a "comfort index," by which they meant a highly generalized statement expressing the level or degree of comfort experienced by students in the climate controlled and in the non-climate controlled schools, and they specified that this statement should be in a form that would permit direct comparisons between schools. The "comfort index" in this sense was to be based upon the operating experience of a full academic term. The need was also expressed for a "comfort index" which would indicate the comfort levels under the different climatic conditions experienced in each school during a year of operation.

The end products visualized by the research staff included two orders of indices. The first was a set of indices which would express the general level of comfort experienced by students when climatic conditions ranged within relatively narrow limits. Such limits would define a subdivision of the range of the total year's climate. These subdivisions would be referred to as zones and the comfort level within the zone as the comfort index, "c," for that zone. The second, and more general order of index, "C," was that expressing the general comfort level within a school over a total year of operation.

A. Basic Considerations

Student comfort is the resultant of a complex interaction of a maze of variables. Of these, some may be classified as climatic and others as metabolic. The clothing of the subjects is also a variable. These investigators suspect that temperamental factors also may influence the expressed comfort of students.

The climatic variables have been the subject of careful investigation over a period of years. These studies have identified temperature as measured by the dry bulb thermometer, radiant heat, relative humidity, and air flow as the principal climatic factors.

The metabolic state of the individual organism is also a factor affecting comfort. The metabolic state varies from individual to individual and from time to time for each individual. It is characteristic of some individuals that their bodies generate more heat than do others. The amount of heat a given individual's body is generating fluctuates with his physiological condition and with the intensity and recency of the exercise in which he has been engaged.

Effects of covering or clothing upon comfort depend upon its insulating properties and will vary with the fabric, with the areas of the body covered, and with the weight, thickness and weave of the cloth. Insulating properties of clothing worn by students in school is variable.

Comfort is the perception of an individual of the state of his adjustment to his environment, and the data on comfort are the personal reports of these perceptions. The investigators entertained the possibility that the students' perceptions, and more certainly the reports they would give of their perceptions, would fluctuate with their changing moods and attitudes toward school in general and the happenings of the moment in particular.

Of the factors enumerated above and others that might be added, some were not measurable and most were not controllable in the setting of this study. Variables that were theoretically controllable were dry bulb temperature, rate of air flow, and, secondarily, relative humidity. In Oak Grove, the climate controlled school, both heating and cooling were provided and the dry bulb temperature was controlled thermostatically and not subject to individual classroom setting or to manipulations by unauthorized persons. Pinellas Park and Tyrone were heated, but no provision was made for cooling other than that which might be obtained by drawing in outside air. Room thermostats were controlled by classroom teachers at Pinellas Park. Temperature was centrally controlled at Tyrone. The movement of air in Oak Grove was accomplished by mechanical means only. Air movement in Pinellas Park was accomplished by the manipulation of windows and by exhaust fans. Air movement in Tyrone was accomplished primarily by manipulating windows and may have been augmented by relatively small fans which were moved in by teachers. The relative humidity of the classrooms was not directly controllable in any of the schools but was a function of the interaction of temperature change, the absolute humidity of the outside air and the moisture added within the rooms.

The research staff investigated the possibility and the feasibility of measuring each of these three factors. Temperature and humidity posed no serious problems. Difficulties involved in obtaining measurements of the rate of air motion at the student stations and under the conditions of classroom operation caused the investigators to decide that this factor must be left to operate as an unknown variable. This study, therefore, was based upon temperature and relative humidity as independent variables and student comfort as the dependent variable.

B. Data Collections

Data required were the dry bulb temperature, the relative humidity and the comfort of students under the given T/H conditions. Conditions to be covered were those of the universe of T/H conditions experienced within each school during each of the school terms included in the total study. Comfort data were basically self reports of comfort made by samples of students experiencing the environmental conditions existing at a given time. The temperatures and humidities were obtained from instruments stationed in the rooms or from a sling psychrometer used for that purpose. Techniques and methods of data collection are reported in this chapter, beginning with the data on student comfort.

1. Design of the Comfort Scale

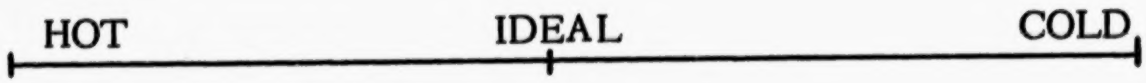
A critical problem faced by the investigators was that of obtaining, or of devising, a scale on which individual students could, and would, report validly and reliably their perception of their physical comfort in the classroom space they occupied. For brevity, the process of obtaining their reports was termed "comfort voting" and the individual record a "comfort vote." These terms will be used in this discussion.

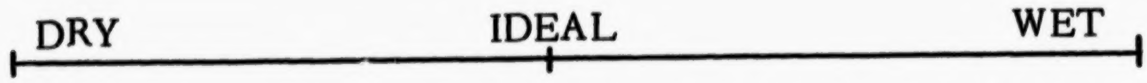
A comfort vote is a psychophysical phenomenon in the sense that it is the individual's psychological reaction to a physical phenomenon. The validity of a given vote is dependent upon the individual's ability to make the discrimination requested and upon his willingness to report accurately the discrimination he makes.

The ability to make comfort discriminations in terms of temperature and humidity is subject to individual differences. It is also an ability that can be developed through training. Under the conditions of this study it did not appear feasible to select individuals who possessed this ability nor to institute a training program for all, or part, of the students. These considerations led the investigators to suspect that the students who were the subjects in this study would be able to make valid discriminations only in terms of large differences in temperature and in humidity.

The student's willingness to report accurately his discrimination was also considered. It was thought that students might be systematically biased in favor of their new schools and hence reluctant to report that they were less than comfortable when, in fact, they were. It was also considered possible that the reports might be affected by the mood of the moment and hence subject to variable error. The general reluctance of subjects to use the extreme portions and particularly the low end of any scale was also known.

It is a generally accepted principle of scale construction that a scale should represent a single valued function. In this study, a single scale requiring the subject to evaluate his comfort in terms of both temperature and humidity would violate this principle. These considerations led to the decision to construct separate scales for temperature and for humidity. The construction evolved as follows. The first draft consisted of three point scales for temperature and for humidity.



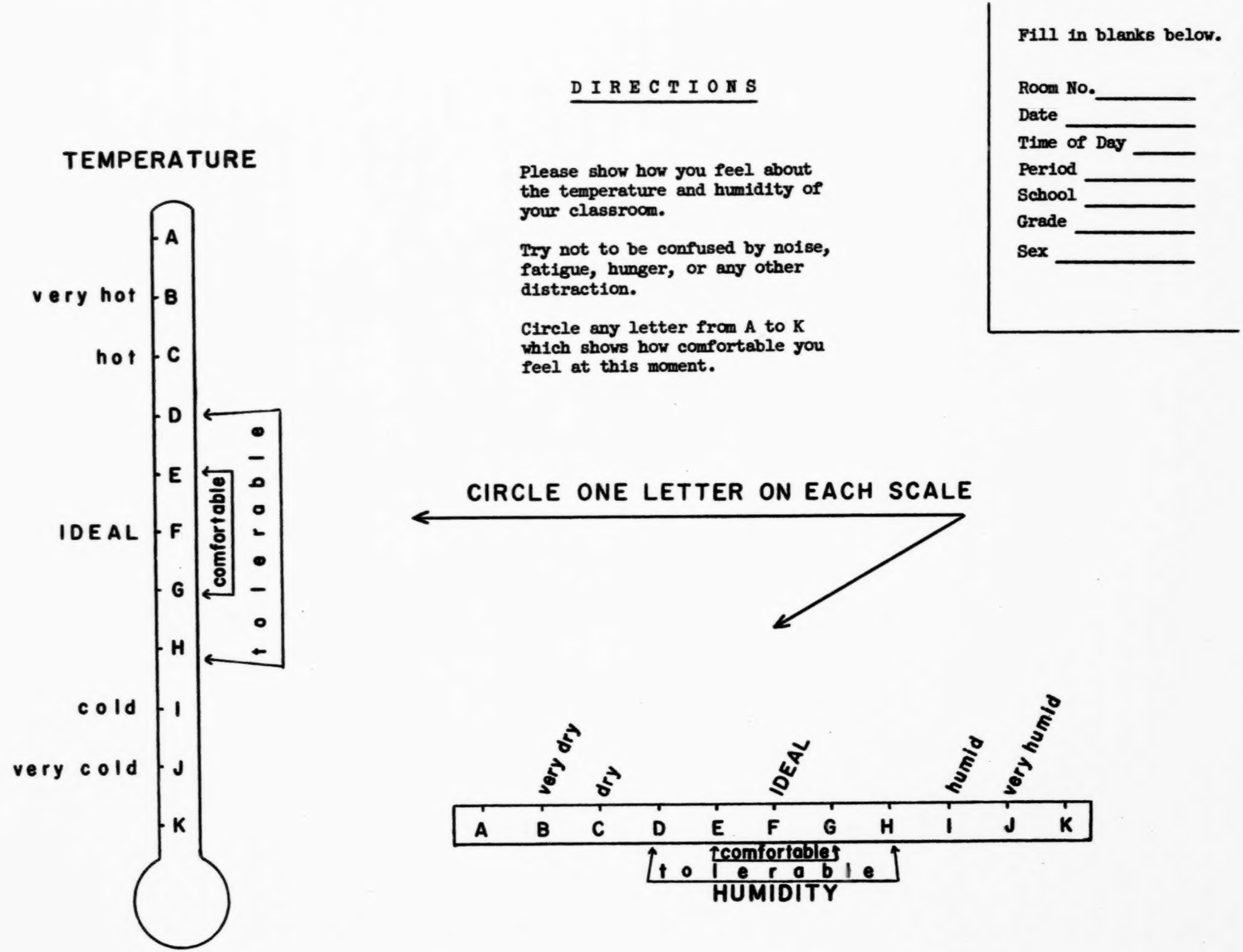


It was thought that students might hesitate to report in the absolute terms of the above scales, so a *tolerable* position was inserted on both sides of the *ideal* position half way between the center and each end. In this form, the *tolerable* positions appeared to be too inviting. They offered easy compromises. This difficulty was resolved by bracketing the three middle positions and labeling them *comfortable*. These were balanced by three divisions of each extreme. The two *tolerable* positions then were restricted to single points dividing the lower of the *comfortable* from the upper of the extreme positions. The eleven positions were lettered A-K.

Directions were developed and the scales were pretested. It was established that they could be self-administered and that students' responses varied as predicted with changes in the T/H conditions. Scales were printed for use in the form shown in Figure VII-1.

2. Temperature and Humidity Data

It was reported in an earlier chapter that instruments were installed in selected classrooms of each building for the continuous recording of temperature and humidity. A sling psychrometer was also available and used for sampling rooms in which there were no instruments. The temperature and the relative humidity of the classroom at the time of each comfort voting was transcribed to the student's scale from the continuous record of the room instrument or from the psychrometer reading, depending upon which was available.


TEMPERATURE
A
very hot
B
hot
C
D
E
IDEAL
F
G
H
cold
I
very cold
J
K
comfortable
tolerable
CIRCLE ONE LETTER ON EACH SCALE
very dry
dry
IDEAL
humid
very humid
A
B
C
D
E
F
G
H
I
J
K
comfortable
tolerable
HUMIDITY

Fill in blanks below.

Room No. ____________

Date ____________

Time of Day ________

Period ____________

School ____________

Grade ____________

Sex ____________

DIRECTIONS

Please show how you feel about the temperature and humidity of your classroom.

Try not to be confused by noise, fatigue, hunger, or any other distraction.

Circle any letter from A to K which shows how comfortable you feel at this moment.

Figure VII-1. -- Scales Utilized for the Reporting of Individual Student Comfort.

3. The Sampling Design

It was necessary for comfort votes to cover both the conditions of T/H and the populations in each of the schools. The necessity to cover the climatic conditions arose from the fact that conditions could not be pre-determined and tested in advance or duplicated by manipulating classroom climates because the manipulation would interfere with normal school operation. The goal was complete coverage of conditions to assure the inclusion of all school days in the calculation of the annual comfort indices. A wide and representative coverage of the student population under each climatic condition was desired because this was the only feasible way to randomize student differences.

The investigators developed sampling designs intended to stratify conditions and to randomize subjects. The summer school of 1961 was not sampled because the investigators were unable to prepare for the work that early in the study. For the summer of 1962, the school day was stratified by hour, 9:00, 10:15, and 11:30 and the week by days, Monday, Wednesday, and Friday. Rooms of students who were enrolled for the full six weeks were assigned to vote on a rotating basis primarily over hours and secondarily over days. All students in a given room thus voted twice at each of the above hours on two of the three designated days of the week. All students present at the designated time and place voted and each student voted six times.

For 1961-62, the school year was stratified by month, week, day of week and hour of day and each school by room. This assured a systematic sampling of conditions within rooms. The practice followed during 1961-62 was that when the date and hour had been determined for voting in a given room, names of students were selected by chance from the roll of the class that was scheduled to be meeting in the room. Approximately a 10% sampling density of each room was obtained at each voting session. Students received their materials in a sealed and personally addressed envelope, marked their scales and sealed them in an envelope before returning them to the teacher.

Actual voting took place after more than 30 minutes of the class hour had passed. Actual temperatures and humidities of the rooms at the time ballots were marked were read from the instrument record and written on the marked scales when these were opened by the research staff. This procedure limited the 1961-62 coverage to those rooms in which instruments were installed.

The above procedure was modified during the year 1962-63 by obtaining votes from all students present at the time of voting. A member of the research staff conducted all balloting during the second year.

He carried a sling psychrometer and read the temperatures and humidities immediately after ballots were marked. This procedure made possible a greater coverage of rooms and increased the sampling density per condition. Data for the two years were pooled and treated as a unit in the analyses described in the next section.

C. Data Reduction

Treatment of comfort data involved three processes. The first process was that of converting scaled votes of students to the dichotomy comfortable and uncomfortable. The second was that of developing zones of comfort based upon the transformed comfort votes and upon T/H conditions. The third was the derivation of annual comfort indices using zone indices developed through the previously mentioned process and mean daily T/H conditions presented in Chapter II. These three processes will be explained in turn.

1. Conversion of Student Comfort Votes

Raw data yielded by each student's comfort vote consisted of his evaluation on an eleven point scale of his comfort in terms of temperature and his evaluation on an eleven point scale of his comfort in terms of humidity. To these were added the dry bulb temperature and the relative humidity of the room at the time of voting. Using these data, a methodology was devised whereby the best estimate could be made of the level of comfort under each T/H condition. A methodology was also devised for the establishment of zones of comfort and for the computation of an annual index of comfort for each building.

The student recorded two responses on two linear scales under known conditions of T/H. The given T/H condition may be considered a square of unit dimensions. The linear scales may be considered to be unit lengths placed at right angles intersecting at their midpoints and superimposed upon the unit T/H area. The result is shown in Figure VII-2. If the eleven lettered positions on each scale are used as coordinates of the grid, the positions marked by the student may be used to locate his composite evaluation of the given T/H condition. His composite evaluation can fall in one, and only one, of the subdivisions of the total area. It may be within the small square in the middle labeled Comfortable. It may fall outside of the Comfortable but not outside of Tolerable. It may fall outside of the Tolerable into the area marked Uncomfortable. Since each student's vote under the given T/H condition must fall into

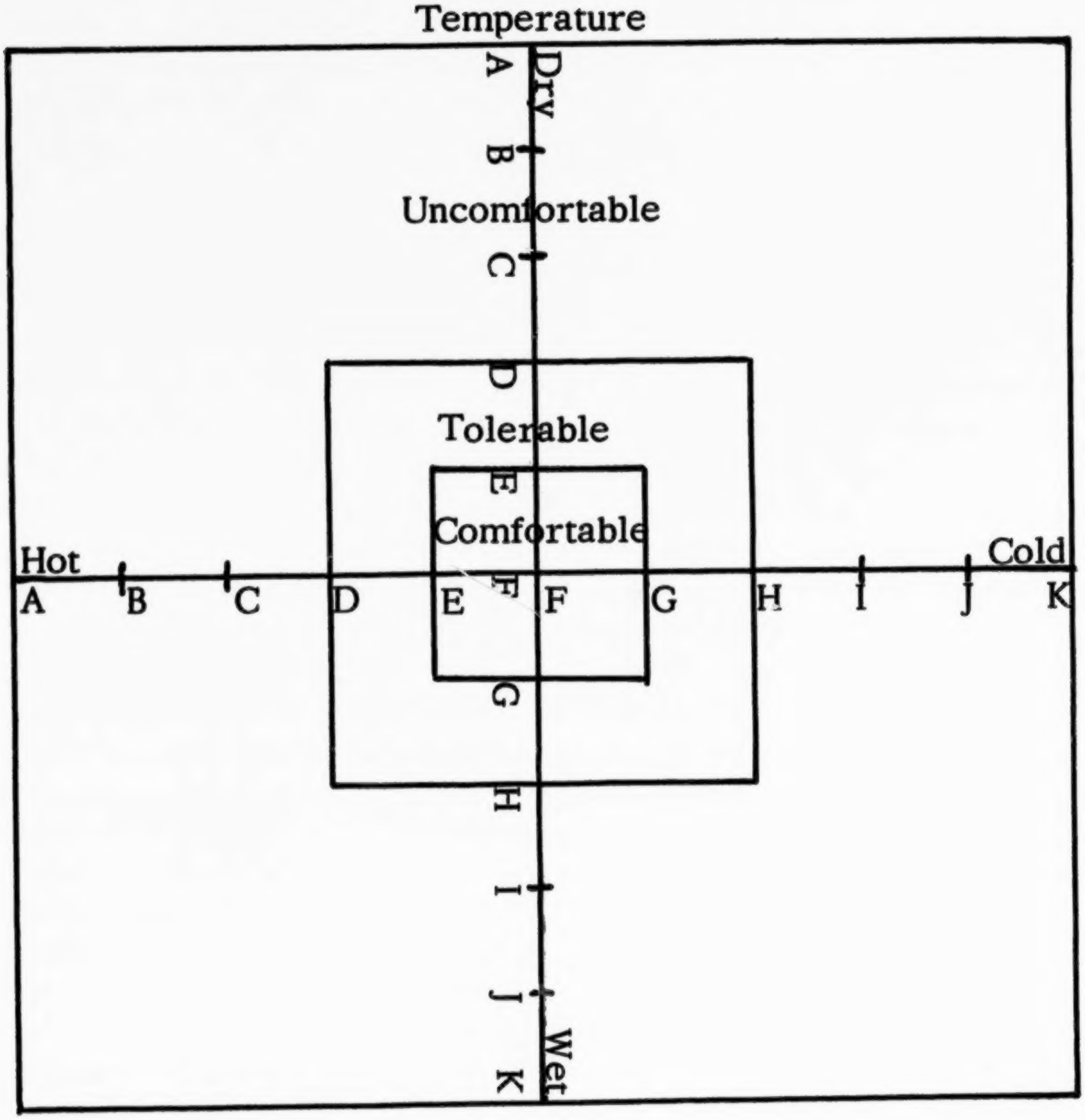

Temperature
Dry
Wet
Hot
Cold
Uncomfortable
Tolerable
Comfortable
A
B
C
D
E
F
G
H
I
J
K

Figure VII-2. -- Schematic Basis for the Three-way Classification of Student Comfort Votes.

one of these three areas, they may be summed over N students to obtain:

$n_c + n_t + n_u = N$, the subscripts c, t, and u meaning Comfortable, Tolerable and Uncomfortable, respectively.

This relationship clearly indicates the division between those who are assuredly comfortable because they voted Comfortable on both scales and those who are assuredly uncomfortable because they voted in the region outside of Tolerable. Those who voted Tolerable occupy an ambiguous position in terms of the dichotomy, Comfort vs. Discomfort. It seemed necessary to dichotomize the data to compute the desired comfort index.[1] While several alternatives were available, it seemed preferable to divide the number voting Tolerable proportionally between the Comfortable and the Uncomfortable categories.

After dichotomizing the votes for any area, a comfort index for that area was computed by dividing the number comfortable, n_c, by the total number, N. This index is in the form of a decimal fraction and expresses the proportion of students who were comfortable under the specific T/H condition. It should be noted in passing that in the iterative process of combining areas to be described later, the three classifications of votes were retained and the apportionment of the Tolerable votes was made anew at each step.

The most elemental cells in the total T/H surface which could have been used were $1^o/1\%$. The consideration of previous work in this field led to the decision to treat relative humidity in bands of 10% because it was extremely doubtful that within normal ranges these subjects could make reliable discriminations between smaller units. Therefore, the basic tables upon which subsequent work was based were in units of $1^o / 10\%$.

Basic data for each school are reported in Tables VII-1, VII-2, VII-3 and VII-4. Each cell of these tables reports in the first column the number voting Comfortable, Tolerable and Uncomfortable and the total vote. The entries in the second column are the proportions in each category. These tables are inserted for reference only. The exposition of the methodology developed for cumulating these cell data into comfort zones follows in Section 2.

---

[1] The investigators considered assigning arbitrary scale values to positions. They rejected this approach because it afforded no basis for making the dichotomy which seemed to be an eventual necessity.

Table VII-1 to 4. -- Number and Percentages of Students Voting Comfortable, Tolerable

Table VII-1 Oak Grove

Read the cells as:

	N	%
Comfortable	1	14
Tolerable	5	72
Uncomfortable	1	14
Total	7	

RH	66	67	68	69	70	71	72	73	74	75	76	77	78	79
70%			1 14 5 72 1 14 7	6 75 2 25 0 0 8		8 80 2 20 0 0 10	8 62 3 23 2 15 13	9 60 4 27 2 13 15	20 51 11 28 8 21 39	3 60 0 0 2 40 5	3 50 3 50 0 0 6			
60%				8 89 1 11 0 0 9	10 91 1 9 0 0 11	10 72 2 14 2 14 14	52 66 13 17 13 17 78	41 62 14 21 11 17 66	66 71 19 20 8 9 93	15 88 1 6 1 6 17	20 53 11 29 7 18 38	8 53 3 20 4 27 15	1 14 0 0 6 86 7	
50%					2 33 3 50 1 17 6		12 60 7 35 1 5 20	48 75 11 17 5 8 64	146 76 27 14 20 10 193	266 73 76 21 22 6 364	84 71 19 16 16 13 119	25 69 9 25 2 6 36	38 72 9 17 6 11 53	
40%		3 60 2 40 0 0 5					21 84 2 8 2 8 25	9 75 0 0 3 25 12	28 78 2 5 6 17 36	44 79 11 20 1 2 56	7 46 4 27 4 27 15	7 70 1 10 2 20 10	74 54 26 19 37 27 137	11 48 9 39 3 13 23
30%							18 62 6 21 5 17 29						38 70 11 20 5 10 54	
20%										11 58 5 26 3 16 19				

Table VII-2 Pinellas Park

Read the cells as:

	N	%
Comfortable	6	24
Tolerable	6	24
Uncomfortable	13	52
Total	25	

RH	66	67	68	69	70	71	72	73	74	75	76	77	78	79
70%				6 24 6 24 13 52 25							15 35 15 35 13 30 43	6 46 6 46 1 8 13	25 66 4 11 9 24 38	3 60 2 40 0 0 5
60%											7 44 4 25 5 31 16	25 57 5 11 14 32 44	21 41 13 25 17 33 51	84 68 29 23 11 9 124
50%									28 46 14 23 19 31 61	65 81 11 14 4 5 80	31 74 6 14 5 12 42	50 49 26 26 26 25 102	20 56 5 14 11 30 36	47 54 19 22 21 24 87
40%						13 59 4 18 5 23 22	12 36 9 28 12 36 33		30 52 13 22 15 26 58	71 56 38 30 17 14 126	28 46 20 33 13 21 61	19 38 15 30 16 32 50	34 49 16 23 20 28 70	11 58 2 10 6 32 19
30%							10 36 14 50 4 14 28						17 77 3 14 2 9 22	

Table VII-3 Tyrone

Read the cells as:

	N	%
Comfortable	6	43
Tolerable	3	21
Uncomfortable	5	36
Total	14	

RH	66	67	68	69	70	71	72	73	74	75	76	77	78	79
80%							6 43 3 21 5 36 14	3 30 6 60 1 10 10	14 64 4 18 4 18 22		2 25 4 50 2 25 8		5 63 2 25 1 12 8	
70%								5 36 8 57 1 7 14	7 44 3 19 6 37 16	18 69 6 23 2 8 26	14 58 6 25 4 17 24	42 58 23 32 8 10 73	16 59 5 19 6 22 27	5 14 10 28 21 58 36
60%							7 47 6 40 2 13 15		1 17 5 83 0 0 6	35 43 27 33 20 24 82	43 52 27 32 13 16 83	26 53 18 37 5 10 49	2 33 3 50 1 17 6	
50%				3 14 5 24 13 62 21			3 38 2 25 3 38 8	4 50 2 25 2 25 8	14 31 16 36 15 33 45	35 44 34 43 10 13 79	21 29 34 47 17 24 72	6 43 5 36 3 21 14	4 67 1 17 1 17 6	7 39 9 50 2 11 18
40%	6 67 2 22 1 11 9						6 75 0 0 2 25 8	3 33 6 67 0 0 9	25 30 41 49 18 21 84	17 63 7 26 3 11 27	18 72 6 24 1 4 25		52 60 24 28 10 12 86	5 63 1 12 2 25 8
30%														
20%							2 29 4 57 1 14 7							

Table VII-4 Northeast

Read the cells as:

	N	%
Comfortable	15	33
Tolerable	8	18
Uncomfortable	22	49
Total	45	

RH	66	67	68	69	70	71	72	73	74	75	76	77	78	79
80%														
70%														
60%														

and Uncomfortable. Basic Tabulations in Units of 1°/10%, 1961-62 and 1962-63 combined.

Table VII-1 Oak Grove

80	81	82	83	84	85	86	87	88	89	90	91	92	
													70%
													60%
													50%
													40%
													30%
													20%

Table VII-2 Pinellas Park

3 27 4 36 4 36 11			6 67 2 22 1 11 9		8 28 9 32 11 39 28	27 42 12 18 26 40 65							70%
15 35 11 26 11 39 43	6 16 9 27 22 60 37	17 36 11 23 19 40 47		1 8 4 33 7 58 12	6 32 6 32 7 37 19		6 13 17 35 25 52 48	12 19 12 19 39 62 63				4 13 0 0 27 87 31	60%
19 65 6 21 4 14 29	7 33 7 33 7 33 21		4 16 9 36 12 48 25	4 50 1 12 3 38 8	7 44 2 12 7 44 16	4 27 5 33 6 40 15	1 9 4 36 6 55 11		1 8 0 0 11 92 12	5 17 11 37 14 47 30	4 13 1 3 26 84 31		50%
9 37 7 29 8 33 24						0 0 1 12 7 88 8							40%
													30%

Table VII-3 Tyrone

													80%
5 31 6 38 5 31 16	5 28 6 33 7 39 18	2 18 3 27 6 55 11	2 25 3 38 3 38 8			16 47 9 26 9 26 34							70%
4 57 1 14 2 29 7		6 22 12 44 9 33 27	5 33 4 27 6 40 15	5 26 3 16 11 58 19	49 33 60 41 38 26 147		11 31 16 44 9 25 36	10 16 20 32 32 52 62					60%
18 51 11 31 6 17 35		4 23 4 23 9 54 17											50%
	3 38 2 25 3 38 8												40%
													30%
													20%

Table VII-4 Northeast

	15 33 8 18 22 49 45												80%
					17 30 16 28 24 42 57								70%
						6 12 10 19 36 69 52		8 7 24 22 76 71 108	8 14 16 29 32 57 56				60%

2. Development of Comfort Zones

Comfort zones were operationally defined as subdivisions of the T/H surface within which the differences between comfort levels of the several cells and the comfort level of the zone were attributable to sampling error at the .05 confidence level and between which the differences of those adjacent were not attributable to random error at the same confidence level.

When the differences between the comfort levels of the several cells and the comfort level of the zone of which they are a part may be attributed to sampling error only, the zone may be said to be homogeneous with respect to comfort. When the differences between the comfort levels of zones which are internally homogeneous and adjacent may not be attributed to sampling error, the zones may be said to be discrete. The reason that differences between adjacent zones, and by implication only adjacent zones, are specified is that while comfort levels display a certain symmetry around the zone of maximum comfort, those levels on the warm side are qualitatively different from those of approximately equal comfort on the cool side. It seemed helpful to distinguish between zones on a qualitative basis.

The process of data reduction was iterative. At each stage adjacent cells were combined into larger T/H units only after it had been established that clear cut zones did not emerge. The analysis was considered complete when such zones did emerge. Since pattern analyses do not necessarily yield unique solutions, the investigator is free to specify the kinds of solutions he desires. In this case, temperature was a more important characteristic of the zones than humidity because it was the more readily controllable factor. Therefore, other things being equal, humidities were collapsed with less reluctance than were temperatures.

The specification of a narrowly defined zone of maximum comfort for each building had priority over the establishment of other zones because of the practical value of knowing the T/H conditions under which comfort could be optimized. Zones to either side were established sequentially in their order of removal from the zone of maximum comfort. This strategy left as indeterminate only the outer boundaries of the end zones. These boundaries were indeterminate only because there was no way of determining what the outer boundary would have been if data for more extreme conditions had been collected.

The derivation of comfort zones may be illustrated by using the data for Oak Grove, the climate controlled school. Data in Table VII-1 were collapsed into units of $2^{o}/10\%$. Results are presented in Table VII-5.

From this tabulation all cell entries based upon numbers of less than 20 were dropped. The three entries in the column 74-75°/40-69% suggest the nucleus of the zone of maximum comfort. They meet the criteria of being narrowly defined with respect to temperature, of homogeneity and of being based upon sufficiently large numbers to be stable. The difference between these entries in the table and the entry immediately above suggests a horizontal division of the table at 70% RH, collapsing all humidities below that line. The results that would be obtained by making this division were examined logically and statistically. The upper cell differed from the pooled values below it at the .001 confidence level. The two columns to the right were not linear with respect to humidity. Statistical tests showed that the differences in the 76-77° column might be attributed to chance. Such tests applied to the 78-79° column showed significant differences between either extreme cell and the remainder of the column, but not significant differences between the extremes. It therefore seemed that collapsing the data in the columns to the right would result in no loss of information about humidity at temperatures of 76-79°. The 72-73° column was statistically homogeneous with respect to humidity because no cell differed at the .05 confidence level from the remaining pool of the column. Since cells would be considered individually at the next step, the cell 72°/70% could be recombined with those of its column at that time. Therefore, the table was divided horizontally at the 70% relative humidity level and all humidities below that level were pooled.

Table VII-5. -- Comfort Indices in Units of 2°/10% (T/RH) and the Number of Observations in Each Cell, Oak Grove, 1961-63.

			Temperature		
RH	70°	72°	74°	76°	78°
70%		c=.81 N=28	c=.70 N=44		
60%	c=.91 N= 25	c=.80 N=144	c=.90 N=110	c=.72 N=53	
50%		c=.91 N=84	c=.90 N=557	c=.85 N=155	c=.87 N=53
40%		c=.85 N=37	c=.91 N=92	c=.70 N=25	c=.68 N=160
30%		c=.79 N=29			c=.87 N=54

The next step was the construction of a new table in which the 2° bands of temperature were retained to preserve the possible narrow zone of maximum comfort. Humidities below 70% were pooled. For the cell entries, reference was again made to Table VII-1 to pick up any small cells that were arbitrarily dropped from Table VII-5. No cells below 70° were added because the number of cases in the new cells which would have been created was less than 20. Six cases were recovered for the 70-72° column, 19 cases for the 74-75° column and 7 for the 78-79° column. The results are displayed in Table VII-6. The comfort levels, c, are reported as proportions of the subjects estimated to be comfortable under each cell condition. These were computed in each case by obtaining the total number voting Comfortable, voting Tolerable, and voting Uncomfortable from Table VII-1, dividing the number voting Tolerable proportionately between Comfortable and Uncomfortable and then computing the proportion Comfortable.

Table VII-6. -- Comfort Indices, Number, and Confidence Levels of Differences between Adjacent Cells. Units of 2°/20-69% and 2°/70-79%. Oak Grove, 1961-63.

RH	Temperatures								
	70-71°		72-73°		74-75°		76-77°		78-79°
				.29					
70-79%			c = .81 N = 28		c = .70 N = 44				
		.79		.00		.10			
20-69%	c = .88 N = 31		c = .83 N = 294		c = .90 N = 778		c = .81 N = 233		c = .74 N = 274
		.47		.00		.00		.07	

The entries in the boxes between cells are the confidence levels at which the hypothesis of no significant difference can be rejected. Entries greater than .05 are not in the region of rejection; those of .05 and smaller are. Exact probabilities were rounded to the second decimal place. Those less than .005 were reported as .00.

This table identifies the condition 74-75°/20-69% as the zone of maximum comfort in this school. Its comfort index is .90, higher than any other cell. It differs from all adjacent cells at confidence levels higher than .05. The remaining cells of the table are linked in the sense that none of the cells can be separated from those adjacent at the .05 confidence level.

The next step was testing the possibility of breaking the linked cells into homogeneous and discrete clusters. Starting with the three cells 70-71°/20-69%, 72-73°/20-69%, and 72-73°/70-79% it was determined that at the .00 confidence level these were homogeneous, and also discrete with respect to the zone of maximum comfort. They were discrete with respect to the cell 74-75°/70-79% at the .02 confidence level. They then constituted a second zone. Its comfort index was c=.83.

The three remaining cells were then tested for homogeneity. The two cells in the 76-79°/20-69% region had been shown to be homogeneous because they differed at a confidence level lower than .05. They were then pooled and the relationship between the pooled value and the cell 74-75°/70-79% was tested. This cell differed from the pooled value at the .23 confidence level which established the homogeneity of the zone defined by the three cells. Its comfort index was c=.78.

Three zones of comfort were thus identified for Oak Grove, the climate controlled school. Their boundaries and their comfort indices are shown in Figure VII-3. The same basic methodology was applied in the identification of comfort zones in the two non-climate controlled schools.

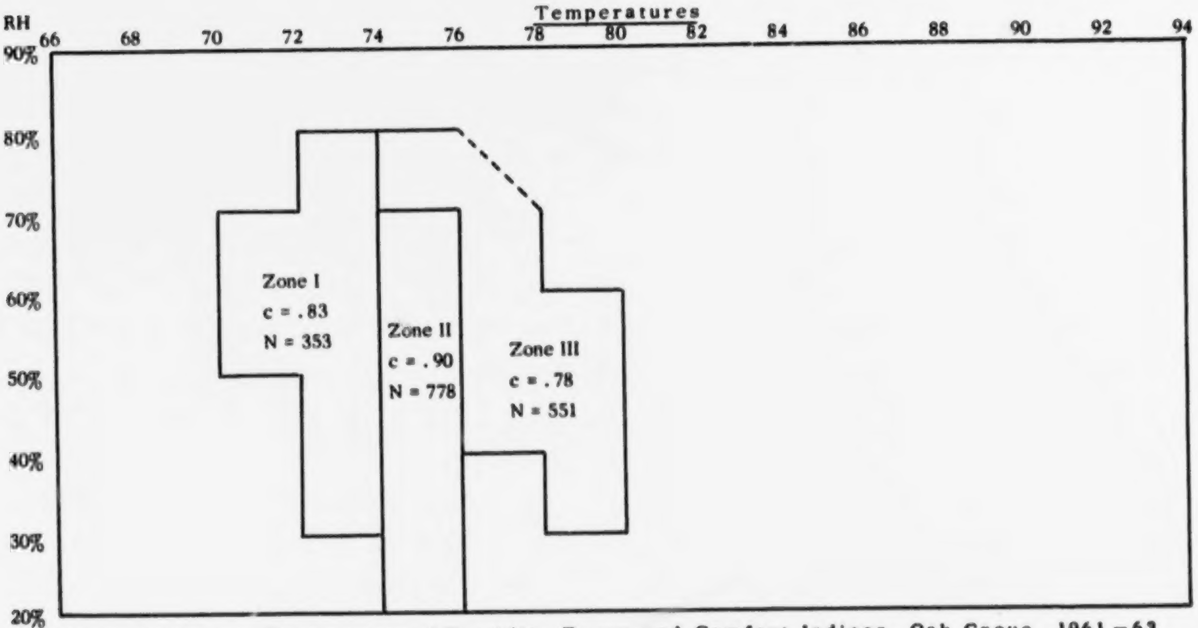


Figure VII-3. -- Temperature / Humidity Zones and Comfort Indices. Oak Grove, 1961 – 63.

3. Development of Annual Comfort Indices

The remaining process to be considered is the computation of the annual comfort indices. The annual comfort index, C, is the single statement expressing in a highly generalized way the level of comfort over all students, over all conditions, over all days of a school term.

The daily mean T/H conditions of each school over the days of the several terms are reported in Chapter II. By fitting the comfort zones derived as reported in the preceding section to the data reported in the right (inside) half of these tables, the number of days falling in each zone was determined. This is illustrated in Table VII-7, using the data for Oak Grove, 1961-62.

Starting at the bottom of this table, Zone I encompasses the following frequencies: 1, 10, 3, 41 and 15 - a total of 70 days; Zone II encompasses 1, 3, 22 and 56 - a total of 82 days; and Zone III encompasses 4, 9, 2 and 5 - a total of 20 days; and 3, 2, 1 and 1 - a total of 7 days experienced conditions not included within the pattern of zones developed for that school.

Table VII-7. -- An Illustrative Table Showing the Frequency Distribution of Inside T/H Readings of Oak Grove, 1961-62, Fitted into the Comfort Zones of that School.

Temperatures	Humidity							
	20-29	30-39	40-49	50-59	60-69	70-79	80-89	90-99
76°		3	4	9	2			
74°		1	3	22	56	5		
72°			1	10	41	15	1	
70°			2	3		1		

Having determined the comfort index, c, for each zone and the number of days, N, falling within each zone, the annual comfort index, C, for each school for each year, or term, was computed as the quotient obtained by summing over all zones the product of each zone index and the number of days falling in that zone and dividing by the total number of days represented. Again using the data for Oak Grove, 1961-62, the process is illustrated in the following example:

Zone	Oak Grove, 1961-62		
	C	N	C X N
I	.83	70	58.10
II	.90	82	73.80
III	.78	20	15.60
	Σ	172	147.50

$$C = \frac{147.50}{172} = .858$$

The reader has noted that seven of the 179 days for which T/H data were reported were not included in the computations of the annual comfort index. The fact that comfort data were not obtained under the conditions represented by these days caused them to be excluded from the pattern of zones developed for that school. In the computation of all comfort indices for academic years, the policy of excluding all such days was followed. In the computation, the T/H conditions during the comfort voting led to an inadequate zoning of the Northeast school. It was the judgment of these investigators that the supplying of estimates of the comfort levels of the excluded T/H conditions would lead to more accurate summer term comfort indices than would the omissions of the days that otherwise would have been excluded. Therefore, estimates were supplied and they are clearly indicated when used in the computations to be reported later.

This concludes the presentation of the techniques and methods employed in deriving the two types of comfort indices. After the presentation of zone indices, c, for each school and annual or term indices, C, for each period of operation of each school, the investigators' observations and evaluations of the general methodology will be reported in the concluding section of this chapter.

D. Comfort Zones of the Schools

The data used for the establishment of individual zones of comfort and patterns of zones for each school are those reported in Tables VII-1, VII-2, VII-3 and VII-4 of this chapter. By the process described in the preceding pages, the cells of each of these tables were successively combined to form larger cells until the desired comfort zones emerged.

The comfort zones based upon the conditions of temperature and of relative humidity at Oak Grove, the climate controlled school, are shown in Figure VII-4. The irregular outline of this figure is caused by the fact that the zones do not extend beyond the conditions for which comfort data were available in usable numbers. The dotted portion in the upper right corner is merely a connection across a condition under which no votes were taken.

Three zones were identified at the climate controlled school. Zone I, the cool zone, had a comfort index of .83. This index indicates that over this zone as a whole, 83% of the students can be considered comfortable. In Zone II, the zone of maximum comfort, the comfort index was .90, and in Zone III, the warm or humid region, the comfort index was .78. The conditions subsumed in the several zones is of interest. The zone of maximum comfort is two degrees in width, 74-76°, and its relative humidity ranges from 20-70%. Zone I, the cool zone, has a maximum width of at least 4°. Its real lower limit cannot be computed because no data from yet cooler temperatures were available. At the lower temperatures, humidities ranging up to 80% were not judged as being deterrent to comfort. Zone III includes at least a 4° span of higher temperatures and one cell having the temperature of Zone II, but relative humidities between 70-80%. This is the only condition under which humidity was indicated as a factor contributing to the lowering of comfort.

Five comfort zones were identified at Pinellas Park, the school which was heated by residential type furnaces and equipped with exhaust fans. This school had large surfaces of clear glass protected by a five foot overhang, but not otherwise shielded from the sun. The zones are shown in Figure VII-5.

In the process of cumulating cells, the total range of humidity was collapsed. It did not appear that this factor exercised an influence over comfort in this school great enough to overcome the confounding effects of uncontrolled variables. Therefore, the comfort zones are shown to be independent of humidity in the range of 30-80%. The first three zones are each 6° in width and the last two are each 4° in width.

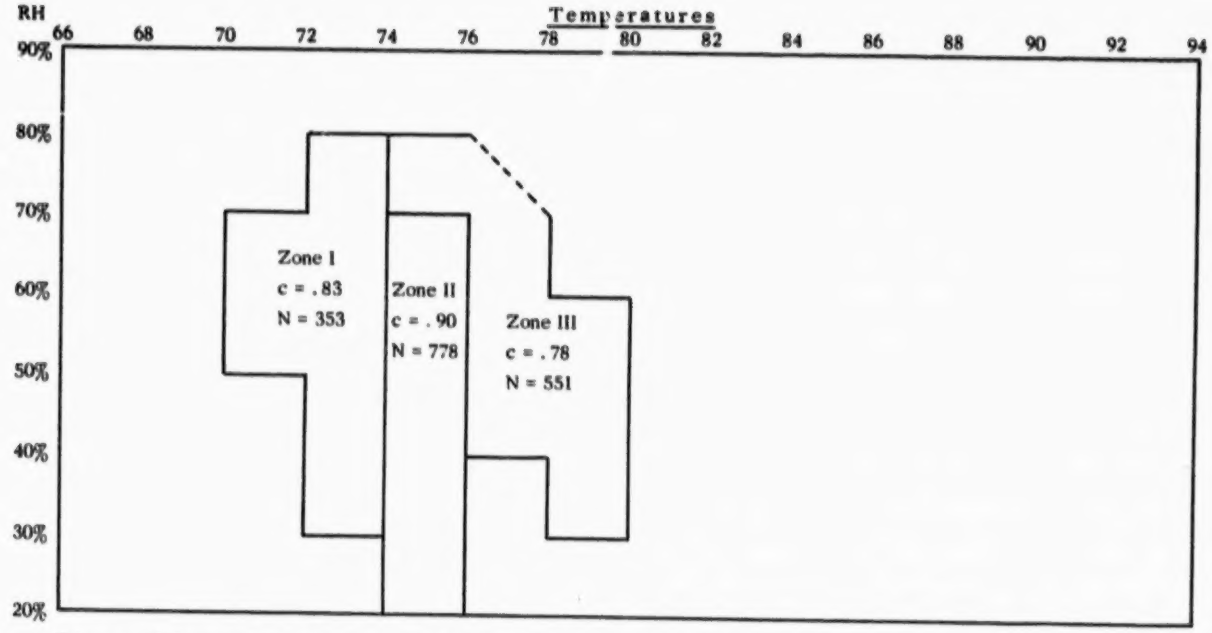


Figure VII-4. -- Temperature / Humidity Zones and Comfort Indices. Oak Grove, 1961 — 63.

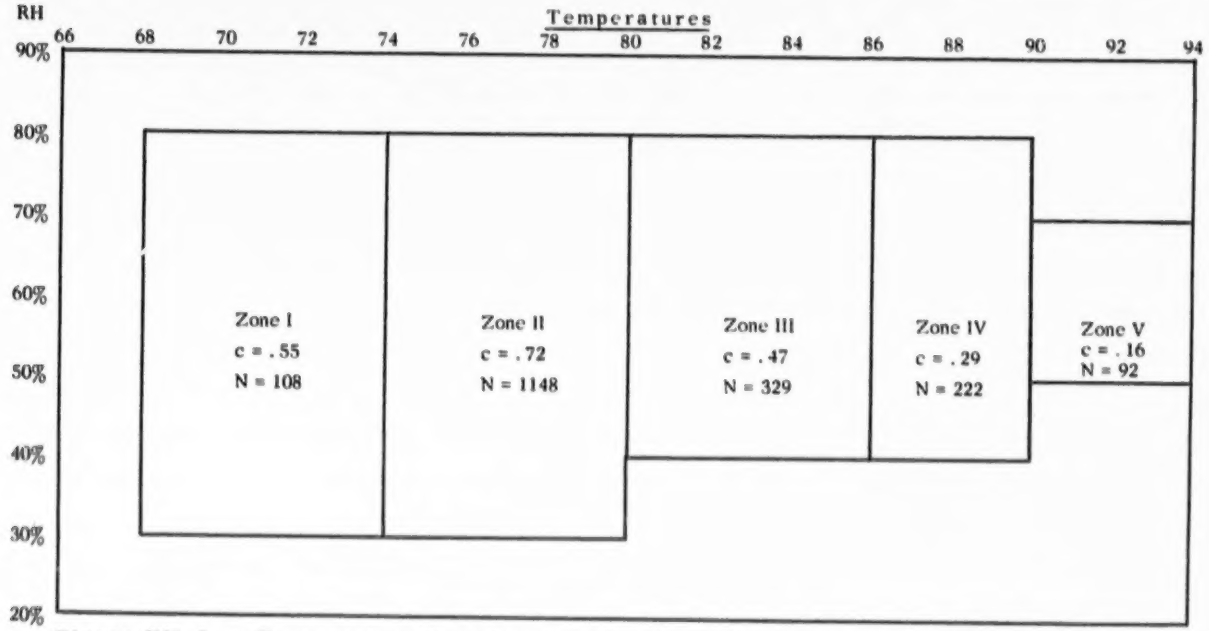


Figure VII-5. -- Temperature/Humidity Zones and Comfort Indices. Pinellas Park, 1961 — 63.

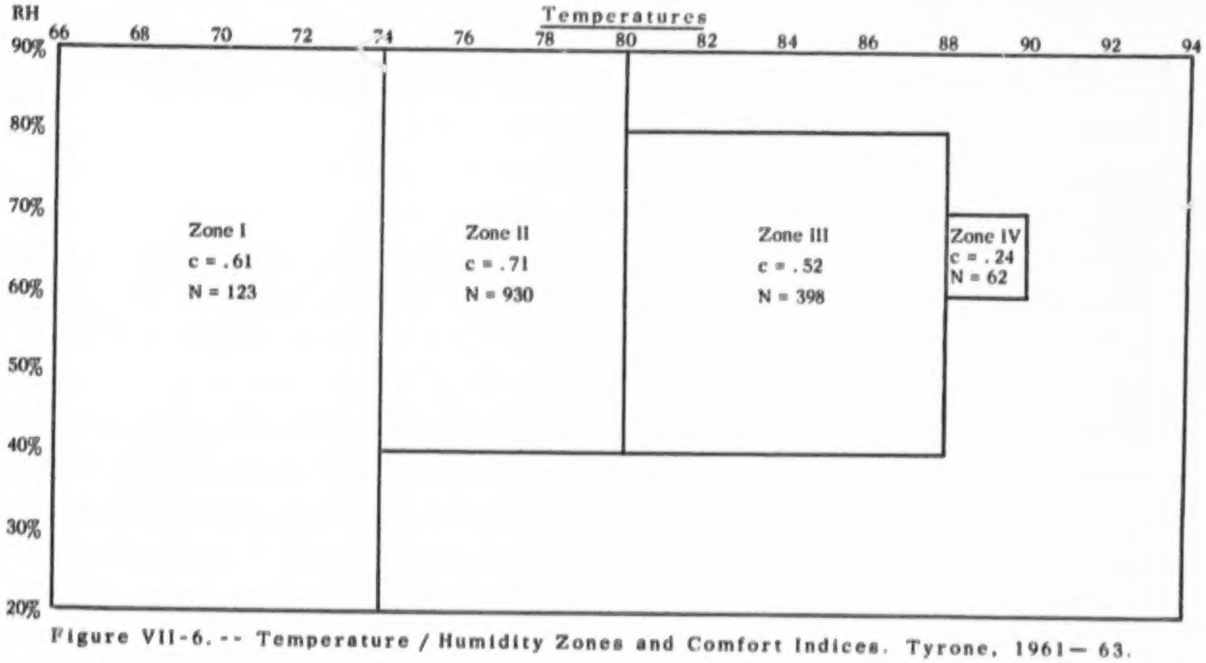


Figure VII-6. -- Temperature / Humidity Zones and Comfort Indices. Tyrone, 1961 — 63.

Again, the effects of uncontrolled variables apparently confounded the relationships between the single variables, temperature and comfort. The narrower zones at the upper end of the temperature range suggest either that temperature differences are more critical at 86^o and above, or that the variability of some, or all, of the unknown factors is reduced under these temperature conditions, or that both of these alternatives are true.

The comfort indices of the zones in this school are not only lower overall than in the climate controlled school but are lower on a zone by zone basis. The latter point is most clearly shown by a comparison of Zone II at Pinellas Park with Zone II at Oak Grove and also with Zones II and III together at Oak Grove.

In both schools Zone II is the zone of maximum comfort. They differ by .18. Zone II at Pinellas Park covers approximately the same T/H conditions as do Zones II and III at Oak Grove. It is .06 lower than the least comfortable condition at Oak Grove. Zones III, IV, and V which become progressively less comfortable represent conditions which were not sampled at Oak Grove.

As a further check on the relationship between comfort and climate control, Tyrone, a second non-climate controlled school, was included in the study. This school was of finger-type design; that is, it consisted of parallel rows of classrooms, the rows being separated by open lawn areas. It was centrally heated and depended upon natural ventilation. Some teachers operated small room fans when, and as, they were so inclined. The comfort zones for the Tyrone school are presented in Figure VII-6.

In this school, as in Pinellas Park, all humidities were collapsed, leaving temperature as the single independent variable. Apparently the uncontrolled variables confounded any influence humidity might have exerted. The four zones identified in this building vary in terms of ranges of temperatures covered. Zone I covers a greater range than could have been covered in either of the other schools simply because it was the only school in which a temperature as low as 66^o was observed. Whether the first zone in either of the other schools would have included this temperature, had it existed, is not known. Again, Zone II represents the condition of maximum comfort. It covers the same temperature range as at Pinellas Park. Its comfort index of .71 does not differ appreciably from that at Pinellas Park, and its position relative to the climate controlled school is also similar. Zone III, commencing at 80^o, is 8^o in width and Zone IV, commencing at 88^o is two degrees in width. Its full width cannot be known because no higher temperatures were observed. Differences between Tyrone and Pinellas Park at temperatures of 80^o and higher appear to be small. Comparisons cannot be made with the climate controlled school because no data were collected in this temperature range at Oak Grove.

Northeast High School was used as the control school during the summer sessions. It was of finger-type construction and quite similar to Tyrone. The research staff selected this school because it promised to be the most comfortable of the non-climate controlled buildings available for summer use. Comfort zones were developed for this school on the basis of data collected during the summer of 1962. The collection of comfort data could not be carried out during the summer of 1961 because the scales for data collection were not available. The two zones depicted in Figure VII-7 had comfort indices of .41 and .13, respectively. These indices were consistently lower for comparable T/H conditions than the indices of the other two non-climate controlled schools which were obtained during the academic year.

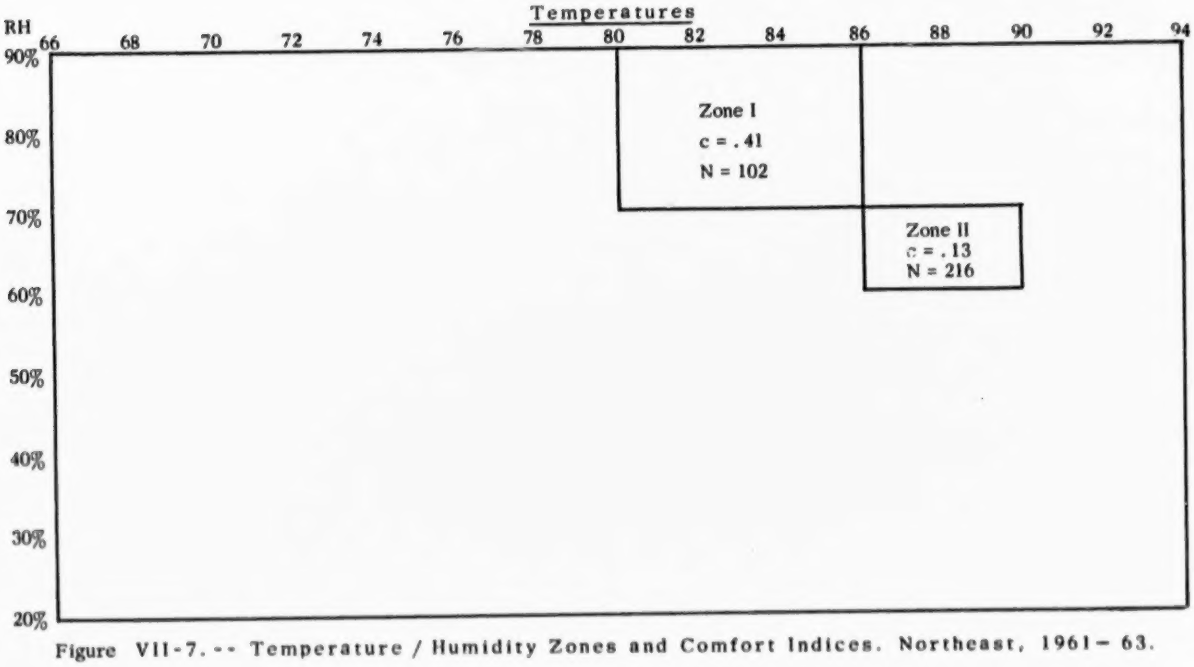


Figure VII-7. -- Temperature / Humidity Zones and Comfort Indices. Northeast, 1961 – 63.

The comfort zones developed thus far express the levels of student comfort realized under specific conditions in each of these schools. The zones in the non-climate controlled schools, operated during the academic year, were established in terms of temperature only. The zones in the climate controlled school were established in terms of temperature plus one condition of temperature/humidity. This condition indicated that at a temperature which was optimum, humidity in the 70-80% range reduced comfort. The zones in the non-climate controlled summer school retained separate humidity bands, but these were inconsistent with generally accepted knowledge in the field and probably indicated that the data were not comprehensive enough to correct the restricted sampling.

If these exceptions may be disregarded for the moment, the comfort indices may be plotted at the midpoints of the temperature ranges of their respective zones. The resulting graphs for the four schools are presented in Figure VII-8. These graphs indicate that the optimum temperature conditions over all schools fell within a narrow range. They indicate that the slope of the comfort line to the cool side did not differ greatly from school to school. They also indicate that slopes to the warm side of the optimum are quite similar over schools and perceptibly steeper than are the slopes to the cool side.

Two differences are apparent. Under the same conditions of temperature, the comfort levels were higher in the climate controlled building than in the non-climate controlled buildings. Temperature conditions which were accompanied by the lower levels of comfort were not observed in the climate controlled building.

E. Annual Comfort Indices of the Schools

The annual, or term, comfort indices, C, are expressions of the general levels of comfort experienced in the several schools over periods of a full school term. As reported in a preceding section they were computed by multiplying each zone index, c, by the number of days whose T/H conditions lay in that zone, summing the products and dividing the sum by the total number of days included in the computations.

The zones and their indices are reported in Figures VII-4, VII-5, VII-6, and VII-7. The additional data required were the number of days whose mean daily T/H conditions were those of the several zones. To obtain the number of days within each zone, the zone pattern of each school was superimposed upon the frequency distribution of inside T/H conditions of each school for a given year, or term. The results are reported in Tables VII-8 to VII-10 inclusive.

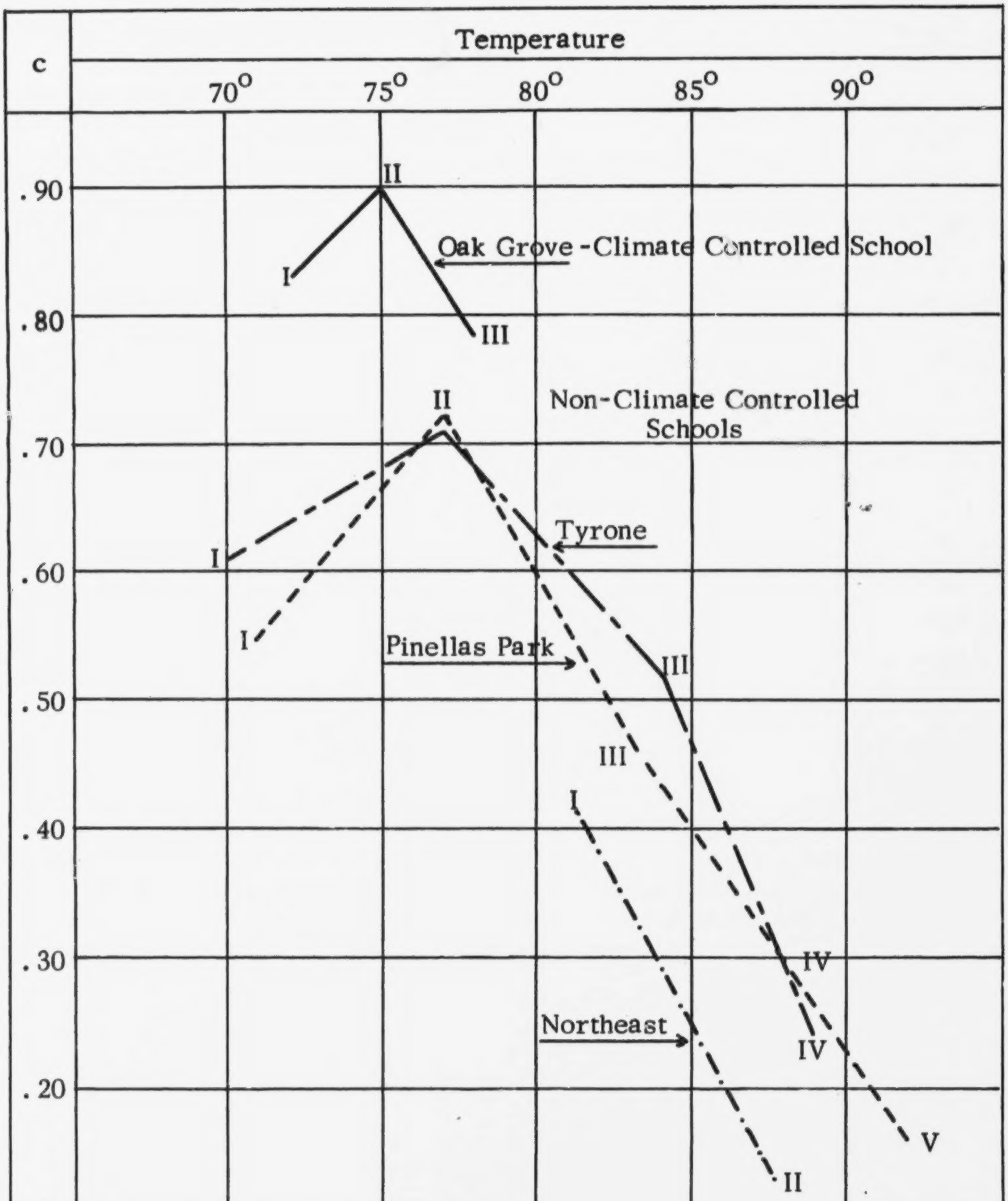


Figure VII-8. -- Graphical Representation of the Relationships Between the Mid-Temperature and Comfort Indices of Zones.

Table VII-8. -- Frequency Distribution of T/H, Inside Readings for Three Schools with Comfort Zones Superimposed - Academic year 1961-62

Temperatures	Humidity							
	20-29	30-39	40-49	50-59	60-69	70-79	80-89	90-99
Oak Grove								
76°		3	4	9	2			
74°		1	3	22	56	5		
72°			1	10	41	15	1	
70°			2	3		1		
Pinellas Park								
90°					1			
88°				1	6	1		
86°				1	14	5		
84°				7	7	6		
82°			1	3	14	6		
80°			1	8	12	7		
78°		9	10	10	14	3	1	
76°		2	7	15	5	1	1	
Tyrone								
84°					7	6		
82°				1	6	10	4	
80°				2	6	15	2	
78°			1	4	9	18	4	
76°			4	8	11	9	2	
74°		4	3	4	7	7	2	
72°			2	7	5	2	1	
70°			1	1	2	1		
68°					1			

Table VII-9. -- Frequency Distribution of T/H, Inside Readings for Three Schools with Comfort Zones Superimposed - Academic year 1962-63

Temperatures	Humidity							
	20-29	30-39	40-49	50-59	60-69	70-79	80-89	90-99
Oak Grove								
80°				1				
78°		1		3	1			
76°		1	6	9	7	1		
74°		2	7	28	43	11		
72°			2	17	16	5		
70°					1			
Pinellas Park								
88°					4	2		
86°				3	15	4		
84°					4	3	3	
82°			1	1	2	6		
80°		4	2	2	5	3	3	
78°		8	16	16	16	7	1	
76°	1		8	6	8	2	1	
74°				1		2		
72°			1					
70°			1					
Tyrone								
86°					2	3		
84°				1	11	6	2	
82°					3	1	6	
80°					3	1	6	3
78°			1	3	3	3	10	4
76°			6	8	6	7	3	
74°			5	11	14	7	2	
72°		1	1	6	6	2	1	
70°				2	2			

Table VII-10. -- Frequency Distribution of T/H, Inside Readings for Northeast and Oak Grove with Comfort Zones Superimposed - Summer Sessions 1961-62.

Temperatures	Humidity							
	20-29	30-39	40-49	50-59	60-69	70-79	80-89	90-99
Oak Grove 1961								
80°					1			
78°					3	1		
76°					22			
74°				2				
Northeast 1961								
88°					1	1		
86°					3	9		
84°					1	9	1	
82°					1			
80°							1	
78°								1
76°								1
Oak Grove 1962								
78°				11	3			
76°				5	5			
Northeast 1962								
90°					2			
88°					7	1		
86°					5	4	1	
84°						1	1	
82°							1	
80°							1	

In each subdivision of these tables, most of the days are "boxed" within one or another of the zones. The entries within the several zones were summed, and the sums entered in the proper row of column two of the Tables VII-11 to 14.

The reader will note that certain entries are not included within boxes. These entries represent T/H conditions which were missed in the process of comfort voting. The stratification which was established to sample conditions was not completely adequate. The omission of these days and of days lost through instrument failure caused those indices reported to be based upon less than full terms of school operation.

The annual or term comfort indices, C, for each school for each of the terms of this study were derived as shown and are reported in Tables VII-11 to VII-14. These indices constitute estimates of the "average" proportion of students who would have indicated that they were comfortable under the varying conditions of their respective schools throughout each school term.

Table VII-11. -- Comfort Indices for the Academic Year 1961-62

Zone	Oak Grove			Pinellas Park			Tyrone		
	c	N	c x N	c	N	c x N	c	N	c x N
I	.83	70	58.10	.55	0		.61	23	14.03
II	.90	82	73.80	.72	76	54.72	.71	93	66.03
III	.78	20	15.60	.47	72	33.84	.52	53	27.56
IV				.29	28	8.12	.24	0	
V				.16	1	.16			
Σ		172	147.50		177	96.84		169	107.62
	C = .858			C = .547			C = .649		

Table VII-12. -- Comfort Indices for the Academic Year 1962-63

Zone	Oak Grove			Pinellas Park			Tyrone		
	c	N	c x N	c	N	c x N	c	N	c x N
I	.83	41	34.03	.55	2	1.10	.61	21	12.81
II	.90	80	72.00	.72	90	64.80	.71	89	63.19
III	.78	38	29.64	.47	29	13.63	.52	31	16.12
IV				.29	28	8.12	.24	0	
V				.16	0				
Σ		159	135.67		149	87.65		141	92.12
	C = .853			C = .589			C = .653		

Table VII-13. -- Comfort Indices for the Summer 1961

Zone	Oak Grove			Northeast		
	c	N	c x N	c	N	c x N
I	.83	0		.41	11	4.51
				.41*	2	.82
II	.90	2	1.80	.13	4	.52
				.13*	10	1.30
III	.78	25	19.50	.71**	2	1.42
	.78*	2	1.56			
Σ		29	22.86		29	8.57
	C = .788			C = .296		

*Days falling outside established comfort zones were assigned comfort indices of the zone into which they probably would have fallen had sampling of conditions been complete.

**Two days experienced lower temperatures than were sampled at Northeast. The index applicable to Tyrone has been used as an estimate because of similarity of buildings.

Table VII-14. --Comfort Indices for the Summer 1962

Zone	Oak Grove			Northeast		
	c	N	c x N	c	N	c x N
I	.83	0		.41	4	1.64
II	.90	0		.13	12	1.56
				.13*	8	1.04
III	.78	24	18.72			
Σ		24	18.72		24	4.24
	C = .78			C = .178		

*Days falling outside established comfort zones were assigned comfort indices of the zone into which they probably would have fallen had sampling of conditions been completed.

The annual, or term, indices afford a basis upon which the comfort conditions in the schools may be compared. These have been plotted on Figure VII-9. This figure shows graphically the superiority in terms of comfort of Oak Grove, the climate controlled school, over each of the two non-climate controlled schools for academic year operation and the even greater superiority over the non-climate controlled school during summer operation.

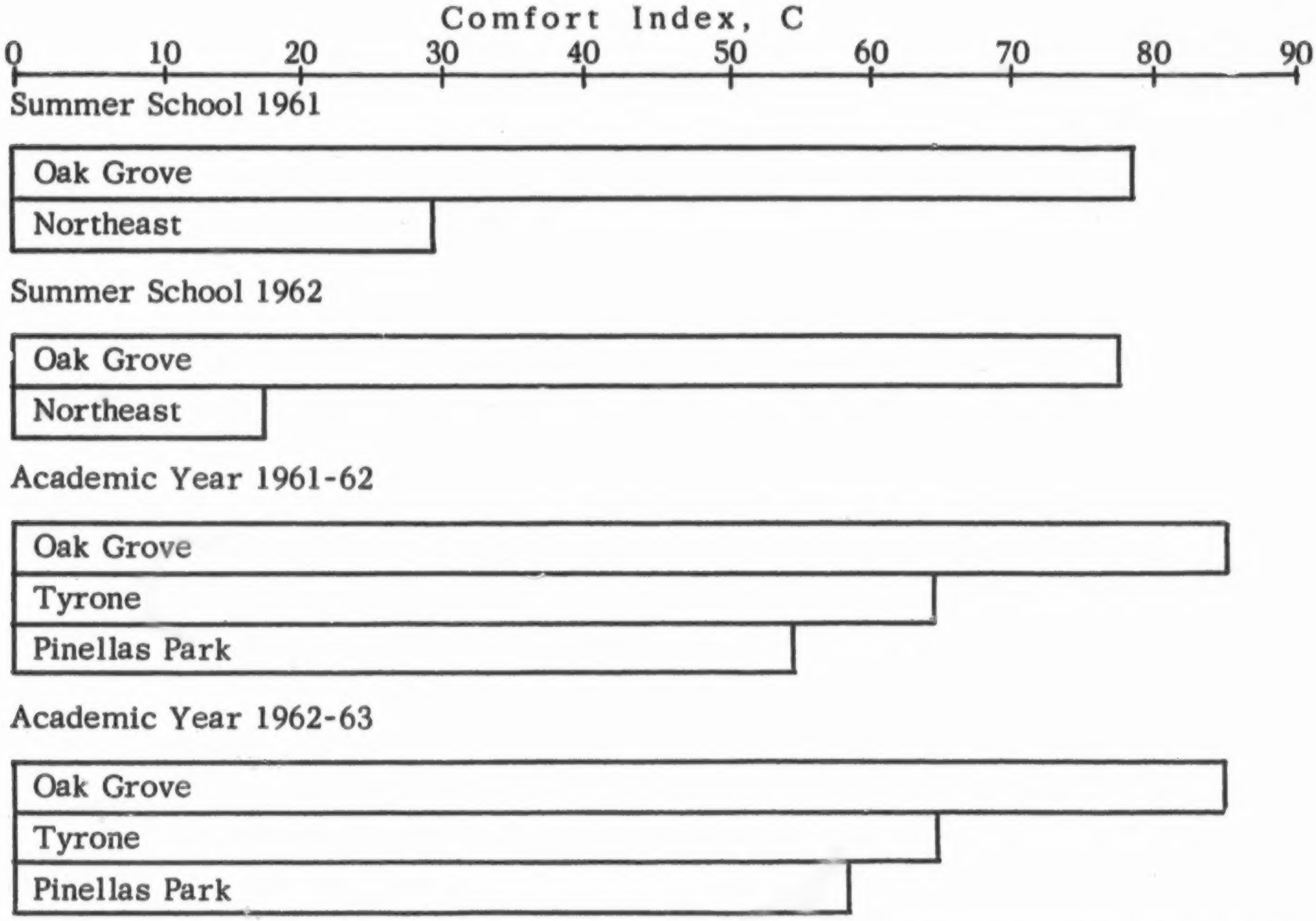


Figure VII-9. -- Comfort Indices of Schools by Academic Terms of the Total Study.

The consistency of the comfort conditions at Oak Grove over two consecutive years and over the two summer terms is also clear. This analysis indicates that it was slightly less comfortable during summers than during the academic years. The comfort levels of Tyrone were highly consistent for the two years and Pinellas Park showed a small difference, which was quite probably spurious because no readings were available for three school weeks in the fall of the year 1962-63.

The greater difference between the comfort levels of the two summer terms at Northeast may be accounted for by small differences in the external climatic conditions.

It is clear that the provisions for climate control made a positive difference in the level of student comfort.

F. Discussion of the Methodology and Results

The investigators have dealt with three schools in operation over two academic years and with two schools operated during two summer terms. The investigators were not at liberty to control the general pattern of operation or to manipulate any of the variables involved. To have done either would have violated the normal operations whose outcomes were the object of the study. The observance of the foregoing conditions makes the research a set of case studies, each dealing with an individual school. The results cannot be generalized by the normal rules of statistical inference but may be of value to those interested in predicting outcomes in specific schools having major elements in common with one or another of the schools herein reported.

The experience in reducing these data to comfort zones afforded interesting checks on the methodology. The total number of student responses in Pinellas Park was 1899, in Tyrone 1513 and in Oak Grove 1682. On the basis of student membership, Oak Grove was sampled more densely than were the other schools. The ranges of temperatures in the non-climate controlled schools were greater than in Oak Grove. The humidities were more erratic and the influence of the uncontrolled variables appeared to be greater and less highly correlated with T/H than in Oak Grove. At stages of the data treatment at which systematic patterns began to emerge in the Oak Grove data, such patterns did not emerge for either of the non-climate controlled schools. It appeared necessary to make more sweeping and more arbitrary decisions than was necessary to make in the former case. For instance, all humidities were collapsed in both schools, leaving only temperature as an independent variable. The investigators feel that having less control of the functional variables in the non-climate controlled schools led to the less systematic relationship between comfort and T/H in these schools than was observed in Oak Grove.

The analysis led to the identification of a different pattern of zones for each school. In each case the pattern and the individual zones appeared reasonable in terms of the exposures, ventilation, and manner in which the local school personnel had operated the school. As a check on the concurrent validity of these results, the zones for each school were reproduced on the grid of dry bulb temperature and relative humidity of the ASHRAE Comfort Chart.[1] The lines of comfort sensations were also reproduced from this chart. The results appear as Figures VII-10, VII-11, and VII-12 for each of the three schools Oak Grove, Pinellas Park and Tyrone, respectively.

The climatic conditions of Oak Grove placed this school in the regions designated slightly cool and comfortable on the ASHRAE Chart. Zone II, the zone of optimum comfort appears as a narrow band lying to the cool side of the line of comfort. The reader will recall that the strategy of the analysis of these data was designed to identify this zone as precisely as possible. The upper limit of the zone of maximum comfort coincides with the relative humidity at which the comfort line curves slightly to the left. The fact that the zone of maximum comfort for the subjects of this study is cooler than that reported in the above reference probably can be accounted for by the differences between the conditions of school operation and the conditions under which the reference study was conducted.

The relationships between the comfort zones of Pinellas Park and the lines of comfort sensation are displayed in Figure VII-11. Zones I and II agree quite closely with the lines of the reference study. Zones III and IV include higher temperatures than are indicated in the reference study. Zone V includes temperatures well above those reported in the reference. The fact that relative humidities were collapsed in the process of analysis precluded the examination of the relationship between relative humidity and comfort sensations at all dry bulb temperatures.

The relationship between the comfort zones of Tyrone and the lines of comfort sensations are displayed in Figure VII-12. Again, Zones I and II agree quite well with the lines 3 and 4 of comfort sensation. Zone III, a zone 8 ° in width, includes both lines 5 and 6 and Zone IV is clearly above the region designated as warm.

The lack of close agreement between the warmer zones reported in this study and the lines of comfort sensation designated 5 and 6, may be attributed to a number of factors. Of these, the principal factor is probably the low sampling density of conditions of higher temperatures and of widely fluctuating humidity in the two non-climate controlled schools. The sparseness of the sampling of comfort contributed to broad definitions of zones in terms of temperature and to the inability to retain humidity as a variable. A second set of factors is probably the variability of such uncontrolled influences as turbulence, radiant heat, clothing and activity level of the subjects.

---

[1] Extracted by permission from ASHRAE GUIDE AND DATA BOOK 1963.

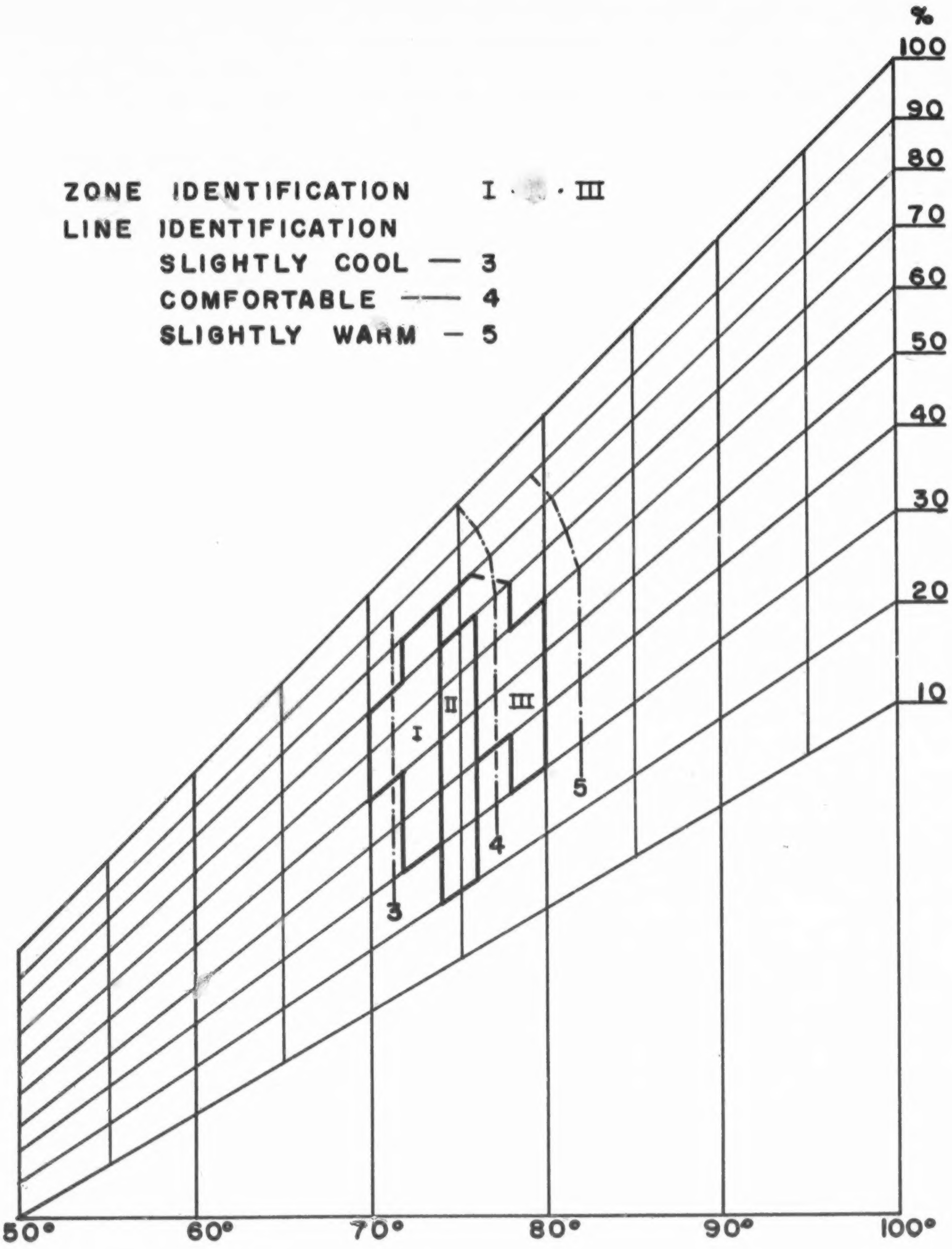


Figure VII-10. -- Oak Grove Comfort Zones and Lines of Comfort Sensations.

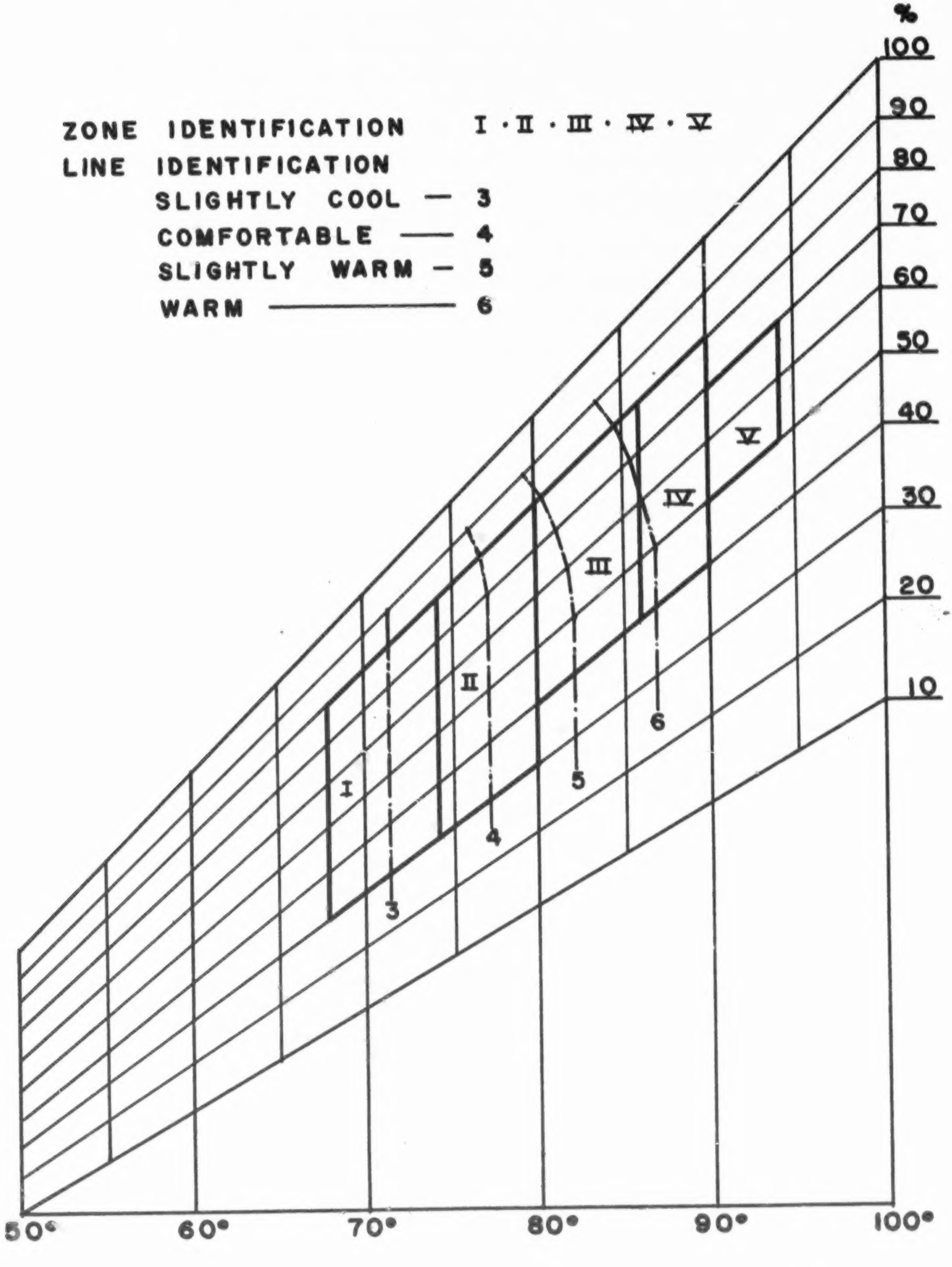


Figure VII-11. -- Pinellas Park Comfort Zones and Lines of Comfort Sensations.

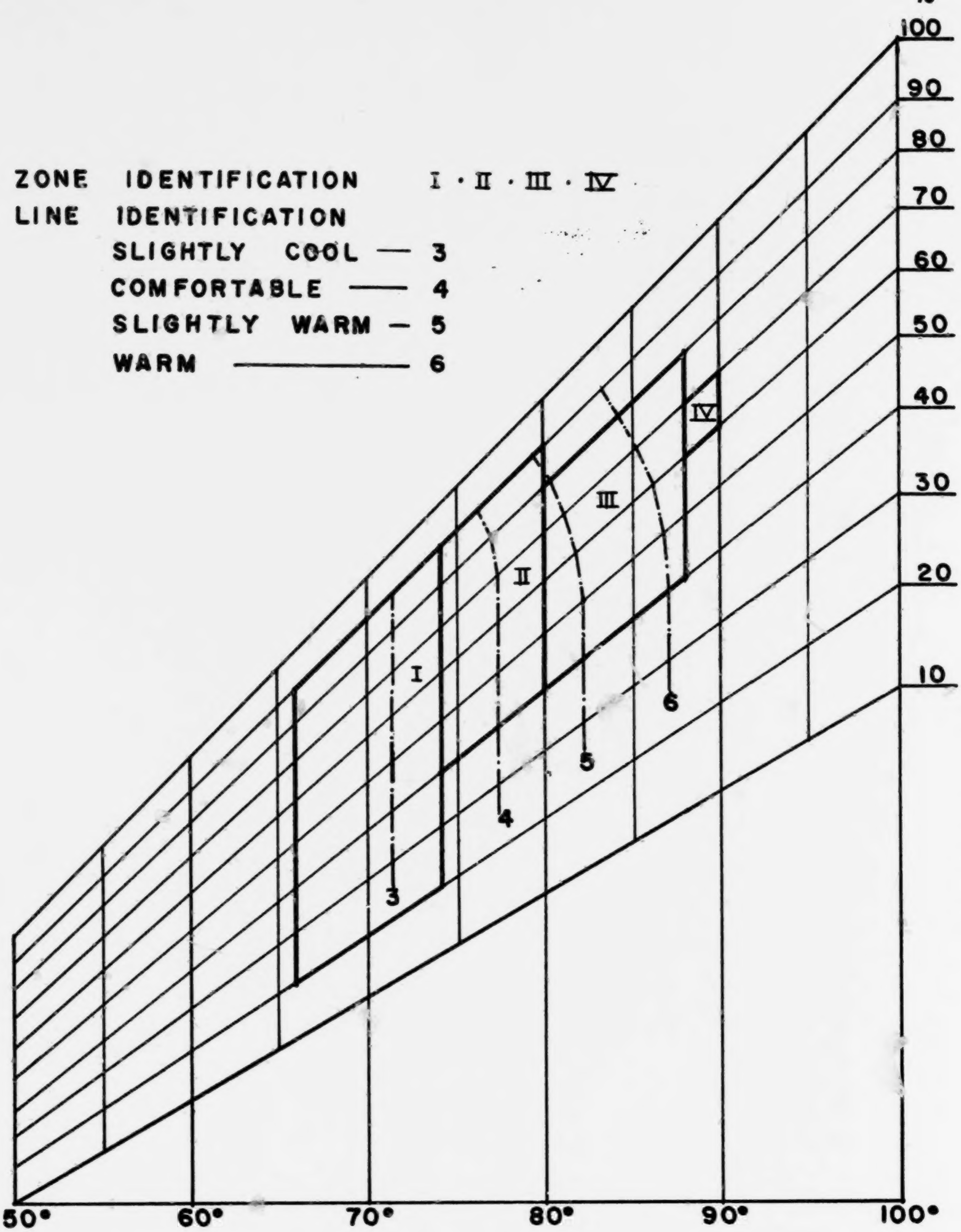


Figure VII-12. -- Tyrone Comfort Zones and Lines of Comfort Sensations.

In summary, the three comfort zones identified at the climate controlled school, Oak Grove, appear to be quite accurate. Zones I and II at each of the two non-climate controlled schools likewise appear to be quite accurate. The warmer zones at the two non-climate controlled schools appear to be too broadly defined. This result was produced in part by the fact that a fairly uniform sampling density of students over schools led to sparse sampling of conditions in those schools experiencing wide ranges of temperatures and humidities. While this defect should be recognized, the general method seems to be useful. It should not substitute for control of variables and is dependent upon the personal ability of the researcher to make sound judgments at those points where his data do not prescribe the next steps to be taken.

A few further observations about the study may be of value to the reader. The investigators purposely chose conservative treatments of the data. In the interpretation of comfort votes, all who indicated that the conditions were tolerable or ideal might have been judged comfortable. This interpretation can be supported with what are perhaps sound, and certainly plausible arguments, but these investigators chose not to so handle the data. Had they done so, all indices would have been numerically larger.

The annual comfort indices were based upon the number of days falling within the zones defined by T/H conditions sampled in the process of taking comfort votes. In the non-climate controlled schools more days fell outside the conditions defined by comfort zones than was true of the climate controlled school; and the bulk of such days experienced conditions which obviously would have placed them in zones having low comfort indices. Had all the days been zoned, the spread between each annual comfort index of the climate controlled school and the corresponding index of each non-climate controlled school would have been greater than here reported. Estimated zone indices were used in the computation of the summer term comfort indices. The sampling of the T/H conditions did not cover those experienced on a number of days during those brief terms. It was felt that the inclusion of estimates for these days would lead to more accurate general comfort indices than would result if such days were omitted.

During the year 1962-63, technical difficulties prevented the collection of data during the first 14 days of school and during four additional days at other times throughout the year. The weather in early September is hot and frequently humid. The omission of 14 hot days probably had little effect upon the index of Oak Grove, but it relieved the annual record of 14 days having low comfort levels at each of the non-climate controlled schools. The omission of 4 days during the summer of 1962 probably had little effect upon the indices reported.

The net effect of the policy decision about the interpretation of the tolerable votes was to produce conservative comfort indices. The effect of the omission of certain days of the school year was the imparting of a bias favorable to the non-climate controlled schools when compared to Oak Grove. The omission of 14 hot days during the year 1962-63 also tends to conceal the fact that the non-air conditioned schools were no more comfortable during the year of the cold winter of 1962-63 than they were during the mild year, 1961-62.

The difference between the climate controlled school and Northeast under conditions of summer operation was expected but its magnitude was not known. The difference between the climate controlled school and Tyrone which was centrally heated and naturally ventilated also may have been expected. The poorest showing was made by Pinellas Park which was equipped with furnaces between adjacent rooms, thermostats controlled within the rooms, exhaust fans in hallways, movable awning windows, and large glass wall areas protected by a 5' overhang. Perhaps a factor contributing to its poor showing was the failure on the part of the teachers to operate the equipment properly. If so, this failure may be very normal for teachers because their primary attention is directed to instruction and other aspects of classroom management.

CHAPTER VIII

THE ACADEMIC ACHIEVEMENT OF STUDENTS

A. The Setting and Preparation for the Study

The comparative study of the academic achievement of pupils in Oak Grove, the climate controlled school, and of pupils in non-climate controlled junior high schools was a central purpose of the total project. Since the primary purpose of the schools is to enhance the academic achievement of pupils, the relationship between climate and pupil achievement was a proper subject for study.

This study was based upon operating schools and its findings were to be addressed to those concerned with the operation of schools and to related professions and groups. These facts implied that total schools should be involved, that the periods of study should be normal units of time, i.e., academic years and summer sessions, and that the findings should be stated in terms normally used to express gains in academic achievement over prolonged periods of instruction, i.e., teachers' marks or standardized test scores.

While it was the purpose of the study to relate climatic conditions to achievement, it was obvious that many factors other than climate affect learning outcomes in school. The investigators could not control such contaminating variables, but they took certain steps to reduce the variability attributable to non-climatic factors.

On the basis of prior knowledge, the investigators included in the study two control schools in which the general achievement level of the pupils could be expected to bracket that of the pupils in the climate controlled school. Comparability of the teaching staffs was carefully considered. Special permits granted by the county administrative staff to students to transfer into, and out of, the schools were studied to ascertain whether this practice was so extensive that it would bias the character of any or all of the three school populations. The curricular content in each of four academic areas--English, mathematics, social studies and science--in grades seven, eight, and nine was explicitly defined and published in study guides. Methods of instruction were not prescribed but were left entirely to the best judgment of the several faculties and individual teachers.

Utilized as criterion measures of achievement were tests which possessed logical curricular validity and a level of statistical reliability comparable to standardized tests generally used in American schools.

Four different instructional periods were included in the study (summer, 1961; summer, 1962; the academic year, 1961-62; and the academic year, 1962-63) and were individually analyzed. The characteristics of the school system, the qualifications of the teaching staffs, the systematic differences in instructional methods, the curricula, the development of tests, the testing program, and the test results will be presented and discussed in the ensuing sections of this report.

The provision for climate control in one school and the lack of such provision in others did not necessarily constitute an experimental treatment. Measures of the independent variable, climate, were required which were functionally related to the dependent variable, achievement. To be functionally related to learning, the phenomenon measured should operate to facilitate or impede learning and should be distributed over the school terms as increments to achievement are theoretically distributed. The measurement of the independent variable, climate, will also be discussed in an ensuing section of this report.

1. The Pinellas County School System

The schools available for study were Oak Grove, the climate controlled junior high school; Pinellas Park, the non-climate controlled junior high school which was designed, built and utilized as a control school for other sections of this study, and eighteen other public junior high schools in Pinellas County, Florida, none of which was climate controlled. By virtue of the fact that all available schools were units within the Pinellas County Public School system, they possessed certain characteristics in common.

The general educational resources available to all schools were determined by common county policies and the county's ability to provide funds. The financial support of the schools has been discussed in a preceding chapter. Since 1947, the county has offered its students 180 legal days of instruction. It has also employed its teaching personnel for a tenth month, which, under the direction of the county superintendent, has been devoted to evaluating and reporting, instructional planning, and in-service education. Members of the administrative and supervisory staff are normally employed on an eleven or twelve month basis.

The county school system made available to the students involved in this study an educational program that met state standards governing length of school year and employment of personnel and supported its program more adequately than did the state as a whole.

The general cultural level of the community is quite generally believed to influence the quality of its schools. One measure of the general cultural level is the median educational age of adults 25 years old and over as reported by the U. S. Bureau of the Census. Table VIII-1 reports these data from the 1950 and 1960 census.[1] Pinellas County and the communities of St. Petersburg and Clearwater were superior to the state median in 1950 and 1960. Pinellas Park was also superior to the state median in 1950, but below that standard in 1960. The sequential order of the communities is Clearwater highest, with St. Petersburg following closely, and Pinellas Park notably lower in the number of school years completed. Between 1950 and 1960, the "median school years completed" dropped for Pinellas County, St. Petersburg, and Pinellas Park and increased slightly for Clearwater.

Table VIII-1. -- Median School Years Completed by Persons 25 Years Old and Over as Reported by the U. S. Bureau of the Census, 1950 and 1960.

		Location (with school in parenthesis)				
Year	Sex	Florida	Pinellas County	Clearwater (Oak Grove)	Pinellas Park (Pinellas Park)	St. Petersburg (Tyrone)
1950	Male	9.2	10.8	11.1		11.1
	Female	10.0	11.7	12.0		11.9
	All Persons	9.6	11.3		10.4*	
1960	Male	10.6	10.7	11.5	10.2	10.6
	Female	11.1	11.4	12.0	10.4	11.3
	All Persons	10.9	11.1			

* 1950 Census reports only the median for All Persons for Pinellas Park.

---

[1] U. S. Bureau of the Census. U. S. Census of Population: 1950, Vol. II. Characteristics of the Population, Part 10, Florida. U. S. Government Printing Office, Washington, D. C., 1952.

U. S. Bureau of the Census. U. S. Census of Population: 1960, General Social and Economic Characteristics, Florida. Final Report PC (1)-11C. U. S. Government Printing Office, Washington, D. C., 1961.

The county school system provided an equal opportunity to all its schools to secure from the county depository or other common sources appropriate textbooks and related instructional materials, as well as library and audio visual materials, and to share the services of the county supervisory personnel. These provisions did not guarantee or even imply the use of identical materials or an absolutely equal share of the supervisory services but did assure each school an equal opportunity to obtain materials and assistance it considered to be suited to its individual needs. While this arrangement did not assure equivalent instructional materials and equivalent supervisory services, it certainly reduced the differences that often exist between schools in separate administrative districts.

Pinellas County pays its classroom teachers on a common salary schedule based upon academic preparation and years of experience. It maintains a teacher personnel department which receives applications and processes credentials. All principals have equal access to the records for purposes of selecting teachers for their respective schools. The individual teachers exercise some choice in their placement, probably being influenced more often by personal convenience, friendships with other teachers, and available teaching assignments than by other considerations. This arrangement does not assure equivalence of teacher competence; but it reduces the differences between schools that often exist when there are differentials of salary, tenure, and other benefits.

A direct measure of teacher competence was not available. In its absence, the investigators compared the teaching staffs of the schools involved in terms of certificate rank, years of experience and number of teachers teaching by permit out of their fields of preparation. These are factors which are in general use in describing faculties. Those factors which characterize professional preparation for the teaching task have been shown to have a low but significant positive correlation with certain measures of teacher competence. The length of teaching experience tends to be quite important up to five years and to have less and less relationship to teaching effectiveness after that period. The chronological age of the teachers is often used in describing teaching faculties, but in practical situations probably contributes little that is independent of preparation and experience.

The academic preparation of teachers in Florida may be expressed in terms of certificate rank. Those who have obtained bachelor's degrees but not master's degrees hold Rank III certificates; those who have obtained master's degrees, but not doctor's degrees or their equivalent as defined by law hold Rank II certificates. Those who have obtained the doctor's degree or the equivalent as defined by law hold Rank I certificates. Teachers of any rank whose teaching assignments are not in conformity with their fields of study may be issued a special permit to teach out of field for a limited period of time. Each school attempts to hold the number of permits to a minimum by assigning teaching responsibilities in the fields of the teacher's preparation.

Differences existed among schools in the intellectual ability and academic achievement of students and these differences were considered important factors. The best available indicators of the intellectual ability and the academic achievement of students in each of the Pinellas County junior high schools were the scores earned on the Florida State-Wide Ninth Grade Testing Program. This testing program was administered in September or October of each school year and all schools of the state participated in it. The battery included the School Ability Test,[1] yielding verbal, quantitative and total scores, and five parts of the Iowa Tests of Educational Development,[2] namely "correctness and appropriateness of expression," "ability to interpret reading materials in the social studies," "ability to interpret reading materials in the natural sciences," and "ability to interpret literary materials." The reports of student performance in the junior high schools of the county for the fall of 1960 were studied.

Other factors were also considered. One school was rejected because it experienced a large influx of winter tourists. Others were rejected because the buildings were old or of such design that their students were uncomfortable under practically all climatic conditions. Schools having small enrollments were dropped from consideration because the number of students limited their usefulness and because they tended to serve specialized types of communities. On the basis of the characteristics of its school population and school plant, Tyrone junior high was selected for inclusion in this test as a second non-climate controlled school.

The data in Table VIII-2 report the standard score means of each of the three schools selected and the percentile rank of each school in the population of white schools in Florida, fall 1960. These data indicate that the general academic ability and achievement of the 9th grade students in Oak Grove could be expected to be consistently higher than in Pinellas Park. They further indicate that the general academic ability and achievement of 9th grade students in Tyrone could be expected to be equal to or greater than those in Oak Grove. An examination of the distribution of student scores indicated that there probably would be extensive overlapping of the scores of pupils in Oak Grove and the scores of pupils in each of the other schools. This consideration was important because this condition would permit the drawing of matched samples, if desired.

---

[1] The School Ability Test, 1955, Educational Testing Service, 20 Nassau Street, Princeton, New Jersey.

[2] The Iowa Tests of Educational Development, 1953, Science Research Associates, West Grant Avenue, Chicago, Illinois.

Table VIII-2. -- SAT and ITED Standard Score Means and Percentile Ranks of 9th Grade Students in Each of Three Schools (1960 Test Administration).

	School Ability Tests		Iowa Tests of Educational Development	
	M	%ile	M	%ile
Oak Grove (N = 189)	50.2	58	49.0	47
Pinellas Park (N = 198)	47.2	30	46.5	27
Tyrone (N = 412)	51.2	65	50.6	60

Summarizing this and certain information given in Chapter I, Pinellas County has a school system that has been administratively stable for a period of time. It has increased in size by 153% over the ten year period, 1950-1960. The per capita expenditure for current operations has been somewhat above the average for the State of Florida. Culturally, it ranks in the upper half of the counties of the state, the median number of school years completed by adults being approximately eleven.

The county school system operates in such manner as to reduce the variability among its schools in such matters as the quality and compensation of its teachers, extent and quality of supervisory services and adequacy of instructional materials. The lengths and number of instructional days are uniform for all schools of the county.

2. The Instructional and Testing Program

The study of student achievement in the schools selected necessitated the specification of content areas to be evaluated and the specification of content to be taught within each of the several areas. The study of achievement further required that instruments be selected and/or developed which would give valid measures of achievement in each area. The content areas selected were English, social studies, mathematics and science. These subject fields together comprise the common core of instruction at the junior high school level and are required of all students. The content in each subject lends itself to clear definition and to division among the three junior high school grades. Measures of achievement in each of these fields are among the most valid and the most reliable in education.

The actual content to be taught in each of these areas had been generally agreed upon by the schools of the county, but inquiry revealed that there remained a considerable variation among schools, particularly in the sequential ordering of specific topics within broad subject fields and the selection of supplementary topics for gifted students. For these reasons, it was advisable that study guides be prepared which would specify the content in each of the four subjects for each grade level.

The county appointed committees of teachers to prepare Study Guides in English, social studies, mathematics, and science for grades seven, eight, and nine. The membership of each committee was drawn from other junior high schools of the county as well as from the schools involved in this project. Each committee functioned under the leadership of the county coordinator for the respective subject field and the total project was coordinated by the Director of Secondary Curriculum. In the preparation of study guides, each committee drew upon the previous curriculum work in the county, upon the available texts and other instructional materials, and upon other professional materials available to them. The guides defined the objectives, general course content and specific content at each grade level in each subdivision of each area. The guides also specified content and activities for gifted students in those courses in which the county provided for the establishment of classes for such students.

After a uniform body of content was specified in the form of Study Guides, the development of a testing program possessing a satisfactory degree of curricular validity was instituted. A number of the best available standardized tests in English, in mathematics, in science and in social studies were subjected to content analyses to determine the extent to which each incorporated the content specified by the Study Guide in the respective field. It was determined that any test selected would have to be supplemented with additional items to obtain a satisfactory content coverage.

The fact that the county schools used the Metropolitan Achievement Tests[1] in an established testing program and that the results of this program could be made available without additional cost or labor influenced the decision of these investigators to use the Metropolitan Tests as a base and to construct tests to supplement their content. The preparation of the specifications for the supplementary tests in each subject field was carried out by these investigators in consultation with the appropriate coordinators and the test specialists in the county. The coordinators made available tests previously developed by teachers of the county and other materials at their disposal. Item pools were developed and tests were written and administered experimentally to students in grades five through ten in seven schools of the county not involved in this study.

---

[1] Metropolitan Achievement Tests. New York: Harcourt, Brace and World, Inc., 1959.

A battery of four tests, each in two forms, was prepared on the basis of the statistical analysis of the item data derived from the experimental administrations. The process of development of the forms finally accepted actually involved the try-out of three preliminary forms. Hence, the two forms utilized in this study were designated Pinellas Supplement IV and Pinellas Supplement V in each subject field. These two forms were administered to the pupils enrolled in grades 7, 8, and 9 in a junior high school not included in this study to obtain local standardization data. This administration was conducted at the end of the academic year. End of year means, standard deviations, and the correlation between forms are reported in Table VIII-3. The raw score distributions were used to develop tables of normalized "T" scores for each form. Student performance on the two forms could then be compared on the basis of the standard score tables.

Table VIII-3. -- Standardization Data for Pinellas Supplementary Tests.

	English	Mathematics	Science	Social Studies
Number Items in Each Form	30	30	45	45
M_{iv}	14.8894	13.5661	22.0338	20.4224
M_v	14.7126	12.8082	22.2795	20.4138
S_{iv}	5.9054	5.4396	7.6330	7.7673
S_v	5.0064	5.0013	7.6114	7.5511
r_{tt}	.7881	.8101	.8420	.8508
N	1390	1390	1390	1390

No attempt was made to control the method of instruction in any school beyond the normal efforts made by the county to maintain as high a level of quality as possible. In substance, the teachers of each of the three schools were told that their school was involved in the study, that their pupils would be given tests at the beginning and at the close of each school year and summer session, that the content for each course was specified in the Study Guides, that the tests were based upon this content, and that, so far as the study was concerned, each teacher was free to employ whatever method or methods he deemed best for his classes. The only systematic difference in method known to these investigators is in the field of social studies. In the Pinellas Park and Tyrone schools, some of the social studies classes were held in the teaching auditorium in each school and were conducted under "team teaching" conditions. In Oak Grove, the climate controlled school, classes in this area, as in all others, were conducted in regular classrooms by individual teachers. The degree to which the administrative provisions for large classes and "team teaching" in social studies in the non-climate controlled schools actually was accompanied by methods of instruction that differed *per se* in effectiveness from the methods practiced in the climate controlled school by individual teachers in smaller classes is not known.

These investigators offer the following statements as personal observations and subjective opinions about the operation of this study of academic achievement. The members of each committee preparing the *Study Guides* were motivated to produce the best guide of which they were capable. Without exception, they took the attitude that as teachers, they and their colleagues needed the authoritative definition of course content which the guides would provide. This attitude seemed to enhance each member's estimate of the professional value of the undertaking and of his personal status, and possibly helped to keep in focus the importance of specifying content that was as free as possible from the influence of the idiosyncracies of individual teachers or individual schools. The guides were well received. There were no allegations of systematic discriminations and the county found it necessary to print additional copies to meet the requests for guides which were made by teachers in other schools, largely because of favorable reports from teachers involved in the research project. The county administrative and supervisory staffs consider the guides to be a valuable asset in their instructional program.

The *Metropolitan Achievement Tests*, with the exception of Form E used in the ninth grade, are in the common professional domain. The two forms of the local supplementary tests were not available to classroom teachers. While it would be possible for any teacher to "teach for" the Metropolitan, it would be difficult, because no teacher knew the specific form that would be used. While there were wishes expressed by individual teachers that they might have copies of the tests, they dropped the matter in every case when told that the tests were "classified" and not available to any teachers. The investigators have no evidence that the results to be reported were affected by unprofessional use of the tests by teachers.

The investigators are confident that there was variability among teachers within schools with respect to the effectiveness of their instructional methods. It would be most unusual if such were not the case. The investigators also think that there were differences between schools in the effectiveness of instruction in a given subject or subject within grade. This, too, would be normal. The investigators also recognize that some portion of variability in the total effectiveness of instructional method might be associated with the total program of schools. The logical effect of each of these three types of variability of instructional method upon the results obtained will be discussed in connection with the analyses of the data.

3. Climate--The Experimental Treatment

The experimental treatment applied in this study was the primary control of temperature and the related control of other climatic variables in Oak Grove, the climate controlled school. The control treatments were the climatic conditions experienced in each of the two control schools. The measurement of these conditions constituted another phase of the overall study. From these studies comfort zones were developed for each school and a comfort index for each zone was derived.

It seemed logical that the comfort of students should be directly related to their productivity in school. Comfort is a psychophysical phenomenon. Theoretically, under conditions of optimum comfort, there should be a minimum of psychological distraction from learning tasks and a minimum of physical energy diverted to the maintenance of adjustment to the environment. Under conditions of reduced comfort, psychological distractions should increase and greater proportions of the potential energy of the students should be diverted to the maintenance of equilibrium with the environment. Thus, it was theorized that comfort was operationally related to achievement. It was the purpose of this section of the study to determine whether or not the measured outcomes of learning in these schools were associated with the comfort of students, which was in turn associated with the climatic conditions.

Annual comfort indices, C, were developed for each term for each of the schools involved in this study. These are reported in Table VIII-4. The data applying to the academic years indicate that as an average, Oak Grove, the climate controlled school, maintained an annual comfort level of approximately .85, Pinellas Park .56, and Tyrone .65. The data applying to the summer schools indicate that Oak Grove maintained an average comfort level of .78 and that Northeast maintained comfort levels of .296 and .178. The difference between terms was greater in this school than in any of the others.

Table VIII-4. -- Annual Comfort Indices, C, of Each School for Each Term.

School	Term			
	Academic Years		Summer Sessions	
	1961-62	1962-63	1961	1962
Oak Grove	.856	.854	.788	.780
Pinellas Park	.547	.589		
Tyrone	.649	.655		
Northeast			.296	.178

The annual index conceals factors which may be of value in relating comfort to learning outcomes. The school week is probably the unit of time in terms of which instruction is more often planned than in any other. The weeks are separated by two or more days in which neither teachers nor students are in the school climate, physically or psychologically. Therefore, weekly comfort indices may be more closely related to student productivity than are annual indices. Weekly indices also permit the analysis of the school year in terms of seasonal differences. The difference between the comfort level of the climate controlled school and each of the others should be greater in the fall and in the spring than during the winter months when heat is presumably required in all schools. Differences in achievement which are associated with climate are, therefore, more likely to occur during the weeks at the beginning and at the close of the school year than during the middle, or winter, periods.

Weekly comfort indices were computed by assigning each school day the comfort index of the zone in which its mean T/H condition placed it. The daily indices were averaged arithmetically by calendar weeks.

Both the absolute difference between schools with respect to the comfort levels of their respective students and the distribution of these differences over each school term were theoretically related to achievement. It is a tacit assumption of educators that increments to achievement are linearly distributed over the school year. The effect of comfort differences will depend, at least in part, upon the similarity of their distribution to the assumed distribution of learning increments. The treatments expressed in terms of comfort will be described in connection with the presentation of the data for each school term.

B. Summer School Studies

The data reported in this section were derived from a study of achievement in the summers of 1961 and 1962. The conditions of summer instruction differ to such an extent from those of the academic year that it seemed wise to treat the summer schools independently.

The academic summer schools in Pinellas County are primarily conducted for remedial purposes. The student population is composed of those who have failed a subject during the academic year. Thus the student body is largely from the lower end of the distribution of academic achievement and the lower end of the distribution of academic ability or academic motivation, or both. "Failure" is not based upon absolute standards but upon the standards set by individual teachers, these being influenced to an unknown degree by policies of their respective schools. The student population may, therefore, be somewhat heterogeneous with respect to initial achievement, ability, and motivation, but all students have in common previous school experience which has included academic failure in the subject in which they are enrolled.

Enrollment in summer school involves the paying of an instructional fee by the student if he is financially able. This payment is waived in those cases where inability to pay is demonstrated. The fees are intended to help defray the salaries of the teachers. The fact that they do involve added cash expenditures or "special arrangements" by the student or his family probably tends to restrict enrollment by excluding those who are unwilling to pay or to request a waiver of fees. Thus, the payment of the fee probably operates as a selective factor, the precise effects of which are not known.

Instruction is quite highly individualized and planned to remedy student weaknesses within a single subject. Thus one student in seventh grade arithmetic may receive the majority of his instruction in fundamental operations and another in problem solving. The gains in student competence are functions of his improvement in the specific sections of the course in which he has concentrated plus improvement in his general competence in the course which comes about because of the interrelationship of the several sections as operationally defined by the teachers and tests.

The summer school is a short (six weeks) period of instruction divided into two semesters, which is further compressed within a four hour morning session of each school day. The student actually devotes 120 clock hours to the study of his subject during the summer while the student during the whole of an academic year devotes 165 clock hours. The relative concentration of study may influence the outcomes differentially.

The number of students enrolled varies widely from course to course. The number of students who drop out during the summer session also varies in the same way. For purposes of this study, the scores that could be considered were only those of students who entered at the beginning and continued throughout the summer session in the same subject area. The number of such students enrolled in the summers of 1961 and 1962 are reported in Table VIII-5. Because of the small number enrolled in social studies and science, achievement in these areas was not analyzed, thus leaving only English and mathematics as subject fields. The small enrollments in certain grades in each of these fields further restricted the detail to which the analyses could be carried.

Table VIII-5. -- Number of Students Included in Study Classified by School, Grade and Subject, Summer of 1961 and of 1962.

School Grade	English 1961	English 1962	Mathematics 1961	Mathematics 1962	Social Studies 1961	Social Studies 1962	Science 1961	Science 1962
Oak Grove								
7	16	8	24	14	0	3	0	2
8	3	15	6	5	1	1	0	0
9	10	25	7	4	2	0	3	1
Total	29	48	37	23	3	4	3	3
Northeast								
7	7	23	2	8	0	1	0	0
8	6	11	6	18	3	0	0	0
9	28	38	4	20	0	1	2	5
Total	41	72	12	46	3	2	2	5

The county operated four summer schools, Oak Grove being one such center. In addition to students regularly attending Oak Grove, students from four other school communities in the north central part of the county were enrolled at this center. Students regularly enrolled in Pinellas Park and in Tyrone attended the summer school conducted in one wing of the Northeast High School. Students from four other junior high schools in the south central part of the county were also enrolled in Northeast. By using Oak Grove and Northeast summer schools in this study, there was, therefore, some element of continuity between the summer school populations and the academic year populations. The inclusion at each center of students from other schools was an important reason for treating the summer sessions as separate sub-studies.

Teachers are employed for summer school on the basis of applications made by the academic year employees of the county. The teaching staff at any given center is composed of persons who have been teachers in the Pinellas County Schools during the previous year, but not necessarily teachers in that particular school. Applications for teaching positions are filed with the Assistant Superintendent for Instruction. Each applicant states the subject field and the school(s) in which he wishes to teach. The assistant superintendent acts upon the principal's recommendation in selecting teachers and assigns them to the several summer schools in accordance with the applicant's wishes and the school's needs.

The distribution of teachers by rank of certificate of the summer schools at Oak Grove and at Northeast for the summers of 1961 and 1962 are reported in Table VIII-6. During the summer of 1961, the climate controlled school had 17% of its teachers holding the Rank I certificate. The difference in the percentage of teachers holding Rank III certificates was negligible each summer. No teacher taught by permit outside his teaching field. On the basis of certificate rank, the faculty at Oak Grove during the summer of 1961 was somewhat more highly trained than at Northeast. Differences during the summer of 1962 were negligible.

Table VIII-6. -- Percentage of Teachers Holding Certificates of Specified Ranks - Oak Grove and Northeast, Summer 1961 and 1962.

Certificate Rank	Percentage by School			
	Oak Grove		Northeast	
	1961	1962	1961	1962
I	17			
II	45	40	60	36
III	38	60	40	64

Professional and related experience are reported in Table VIII-7. These data indicate that the average number of years of credited non-teaching experience was .55 years greater at Northeast than at Oak Grove during the summer of 1961 and that there was no appreciable difference in 1962. Typically, this type of experience was military duty. The faculty at Northeast during both summers had been in the county longer and the total experience of the 1961 faculty was 1.4 years greater and of the 1962 faculty 4.8 years greater than was the experience at Oak Grove. In both schools teachers were experienced and well trained for the work they were doing.

Table VIII-7. -- Mean Number of Years of Experience of Specified Types - Oak Grove and Northeast, Summer 1961 and 1962.

Type of Experience	Mean Years Experience			
	Oak Grove		Northeast	
	1961	1962	1961	1962
Credited, Non-teaching	0.75	0.30	1.30	0.29
Public School, In-County	4.40	4.90	7.80	8.90
Total Public School	12.20	11.20	13.60	16.00

1. The Summer Study, 1961

The comfort index of Oak Grove over the term of the summer school of 1961 was .788 and of Northeast was .296. These indices were computed by the method presented in another section. They express the proportion of students who could be expected to indicate comfort under the conditions of mean daily temperature and humidity of these schools over the term as a whole. If comfort is a condition conducive to learning, 78.8% of the Oak Grove students were so benefited by their climate, while only 29.6% of the Northeast students were so treated.

The distributions of comfort indices by weeks are presented in Figure VIII-1 for each school. The comfort indices for Oak Grove show only a .05 variability over the six weeks period, ranging from .78 to .83. The largest comfort index for Northeast was .41, which was reached during three of the six weeks. During the three remaining weeks the indices were 30, 24, and 19, respectively. If comfort is conducive to learning, these students experienced three weeks in which they should have learned more than during the remaining half of the term. The physical climates of these two schools certainly differed on an over-all and on a weekly basis.

The program for the measurement of the achievement of students enrolled in the 1961 summer school is presented schematically in Table VIII-8. Because of the limited enrollment in social studies and science, these areas were omitted and only students studying English and mathematics were included in this study, although tests were actually administered to all students present on testing days. Pre-tests were administered during the second and third days of the summer session and post-tests during the last two days. That portion of the program designated as the "Common Examination" was administered by persons associated with the research project and the specific subject tests by the teachers in the respective areas. The teachers in every case were experienced in test administration and the test administration met all conditions necessary for accurate and valid measurement.

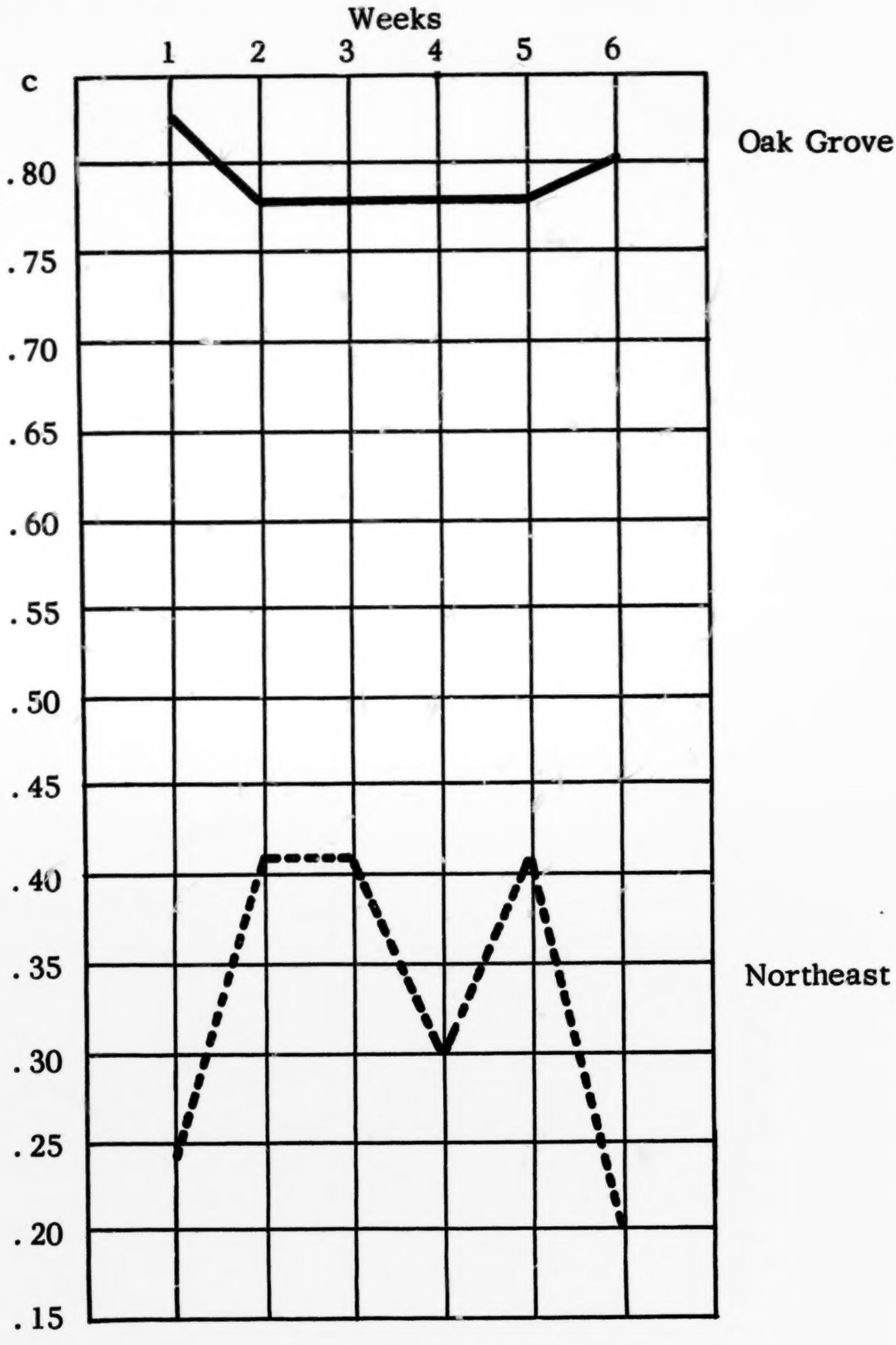


Figure VIII-1.--Weekly Comfort Indices of Oak Grove and Northeast, Summer 1961.

Table VIII-8. -- Testing Program, Summer 1961

Test	Sections	Student Group
Common	Metropolitan Achievement subtests: 1. Word Knowledge 2. Reading 3. Spelling 5. Language Study Skills 9. Social Studies Study Skills	All enrollees
English	Metropolitan Achievement subtests: 1. Word Knowledge 2. Spelling 4. Language Usage	English 7, 8, 9
	Pinellas Supplement subtest: 1. English	English 7, 8, 9
Mathematics	Metropolitan Achievement subtests: 6. Arithmetic Computation 7. Arithmetic Problem Solving and Concepts	Mathematics 7, 8, 9
	Pinellas Supplement subtest: 2. Mathematics	Mathematics 7, 8, 9

These investigators hypothesized that total achievement during the summer session would consist of changes in competence in the specific subject under study and changes in general academic competence, the latter taking place as a result of study in any field. The testing program, therefore, included the administration to students in each subject field of the Metropolitan sub-tests and the appropriate Pinellas supplementary test which together had been accepted as valid measures of achievement in that field. It also included the administration to all students, regardless of their fields of study, of the sub-tests of the Metropolitan which together made up the "Common Examination." Achievement was, in effect, operationally defined as differences between the scores earned on the pre- and post-administration of these tests.

The raw scores on each Metropolitan sub-test were converted to standard scores on the basis of tables published by Harcourt, Brace and World, Inc., the publisher of the tests. The standard scores on all of the sub-tests included in each examination (English, mathematics and the Common

Examination) were added to obtain the total standard score for that examination. The raw scores for each Pinellas supplementary test were converted into normalized "T" scores developed on the basis of the performance of junior high school students in another school of Pinellas County. Because of the fact that the standardization of the Metropolitan tests and of the Pinellas supplementary tests were based upon different populations, the two sets of scores were subjected to independent, parallel analyses. In effect, they were treated as independent measures of achievement in each field.

Two types of analyses of the results will be presented in the sections immediately following. The first set of analyses consists of the comparison of gains and losses in mean achievement in English and mathematics. The data in Table VIII-9 report the mean and the standard deviation of the distribution of the scores earned by all students, grades 7-9, inclusive, enrolled and taking both pre-and-post-tests in English and mathematics in each school; the differences between specified means; and the number of students involved in each classification.

Table VIII-9. -- Analyses of Mean Scores by School and by Subject Test, Summer 1961.

School	Test	N	Stat.	Pre-test	Post-test	Gain	Loss	Diff. OG-NE
Oak Grove	Metro. Lang.	29	Mean	137.76	144.41	6.65		+4.99
			S.D.	20.53	19.16			
Northeast		41	Mean	139.41	141.07	1.66		
			S.D.	21.34	22.01			
Oak Grove	Pinellas English	29	Mean	42.21	46.93	4.72		+6.04
			S.D.	7.28	8.64			
Northeast		41	Mean	46.78	45.46		1.32	
			S.D.	6.59	8.52			
Oak Grove	Metro. Arith.	37	Mean	92.33	93.11	0.78		+17.42
			S.D.	19.66	20.72			
Northeast		11	Mean	100.09	83.45		16.64	
			S.D.	17.77	10.49			
Oak Grove	Pinellas Math.	37	Mean	42.24	45.22	2.98		+3.62
			S.D.	10.58	9.33			
Northeast		11	Mean	49.18	48.54		0.64	
			S.D.	10.36	12.09			

The data in this table indicate that the mean standard score gains of students enrolled in English and in mathematics in Oak Grove, the climate controlled school, exceeded those of students enrolled in Northeast, the non-climate controlled school, in each of the four comparisons reported. The differences ranged from 3. 62 to 17. 42 standard score units.

Table VIII-10 reports the difference in achievement on the Common Examination for all students in grades 7, 8, and 9, enrolled in English and mathematics in Oak Grove and in Northeast. The mean standard score of pre-and-post-tests, their standard deviations, and an indication of gain or loss in achievement are reported in standard score units.

The average achievement of the students in both subject fields at Oak Grove, as measured by the Common Examination was superior to that of students in Northeast. Students in English at Oak Grove showed a mean gain of 5. 76 standard score units and those at Northeast showed a mean loss of 4. 63 units. This difference amounted to 10. 39 units and favored Oak Grove. Students in mathematics at both schools showed a mean loss on the Common Examination. Those at Oak Grove lost 4. 08 units while those at Northeast lost 24. 75 units. The superiority of students in mathematics at Oak Grove thus resulted from the fact that their loss was less than was the loss of students enrolled in this area at Northeast.

Table VIII-10. -- Analyses of Mean Scores on Common Examination by School and by Subject Studied, Summer 1961.

School	Subject Studied	N	Stat.	Pre-test	Post-test	Gain	Loss	Diff. OG-NE
Oak Grove	English	29	Mean	238. 38	244. 14	5. 76		
			S. D.	34. 73	36. 24			+10. 39
Northeast		41	Mean	233. 95	229. 32		4. 63	
			S. D.	32. 69	33. 76			
Oak Grove	Math.	37	Mean	248. 30	244. 22		4. 08	
			S. D.	49. 14	49. 16			+20. 67
Northeast		12	Mean	269. 17	244. 42		24. 75	
			S. D.	52. 90	47. 69			

The second analysis, that of the differences in achievement on the Common Examination by grade levels for Oak Grove and Northeast, is presented in Table VIII-11. Common Examination pre-and-post-test scores are reported for all students enrolled in these two schools for summer, 1961, regardless of the subjects taken. Again, the mean test scores and gain or loss in achievement is given in standard score units.

Table VIII-11. -- Analyses of Mean Scores of All Students on Common Examination by School and by Grade Level, Summer 1961.

School	Grade	N	Stat.	Pre-test	Post-test	Gain	Loss	Diff. OG-NE
Oak Grove	7	40	Mean	228.32	227.05		1.27	
			S.D.	40.32	38.21			+2.50
Northeast	7	9	Mean	215.44	211.67		3.77	
			S.D.	25.12	23.94			
Oak Grove	8	9	Mean	245.89	249.11	3.22		
			S.D.	18.56	30.70			+6.39
Northeast	8	12	Mean	234.92	231.75		3.17	
			S.D.	27.04	30.04			
Oak Grove	9	17	Mean	279.65	281.88	2.23		
			S.D.	39.36	38.07			+15.20
Northeast	9	32	Mean	252.00	239.03		12.97	
			S.D.	44.83	41.33			

Oak Grove eighth and ninth graders showed a gain in achievement while the seventh graders indicated a loss. Students in all three grades of Northeast showed a loss in achievement. The seventh graders of Oak Grove had less decline in achievement than did the seventh graders of Northeast. This analysis indicates that the mean gains on the general examination of students enrolled in each and all of the three grades at the climate controlled school were greater than those enrolled in the non-climate controlled school.[1]

---

[1] The investigators subjected the data for both summer schools to covariance analyses but did not include reports of these studies because they doubt the appropriateness of the technique. The assumptions underlying covariance are rigorous and the conditions under which this study was conducted, in the opinion of these investigators, do not justify the application of this technique. The results obtained agreed with those derived by analyses which did not require the making of assumptions of doubtful validity.

The summer school of 1961 was only one of two summer schools on which studies of achievement were made. The results obtained from a similar, but not identical, testing program conducted in the same schools during the summer of 1962 will be presented before summarizing these findings.

2. The Summer Study, 1962

Oak Grove and Northeast were utilized for instruction during the summer of 1962. The student body was recruited from the same attendance areas and attended summer school because of failure in the academic subject in which they were enrolled. In 1962, as in 1961, the only subjects in which the enrollments justified inclusion in the study were English and mathematics.

Teachers were selected and assigned in accordance with the same policies that were in effect the preceding year. Since these investigators had no direct measure of teacher competence, the competence of the teachers in these schools in the summer of 1962 was an unknown variable as it was in 1961. These investigators, however, do not know of any influences that operated systematically to secure more competent teachers in one school than in the other. Their distributions by certificate rank and by teaching experience were reported in Tables VIII-6 and VIII-7.

The number of days and the number of hours of instruction during the summer of 1962 were the same as during the previous summer. The purpose of instruction was the same, namely to remedy the defects in the knowledge and skills of the students enrolled in each course and thus enable them to receive credit for that course. Instructional materials were equally available to both schools and utilized as each teacher thought best.

The county assigned a principal for the junior high school grades at Northeast for the summer of 1962. In 1961, one principal had administered and supervised the instruction in grades 7-12 at that school. Since Oak Grove enrolled only grades 7-9, this change tended to equalize the administrative and supervisory provisions for the grades under study. The actual effect of this change upon student achievement is not known.

The comfort index of Oak Grove over the term of the summer school of 1962 was . 78 and of Northeast was . 178. The difference between the two indices was . 602 in 1962, which was somewhat greater than the difference of . 481 for the summer of 1961. The distributions of comfort indices by weeks are presented in Figure VIII-2. This figure shows that the comfort level of Oak Grove was constant at . 78 for all of the six weeks. The index of Northeast varied, indicating a high reading of . 32 for the first week, of . 24 for two weeks and of . 13 for three weeks. The schools certainly differed in terms of the levels of comfort experienced by the students.

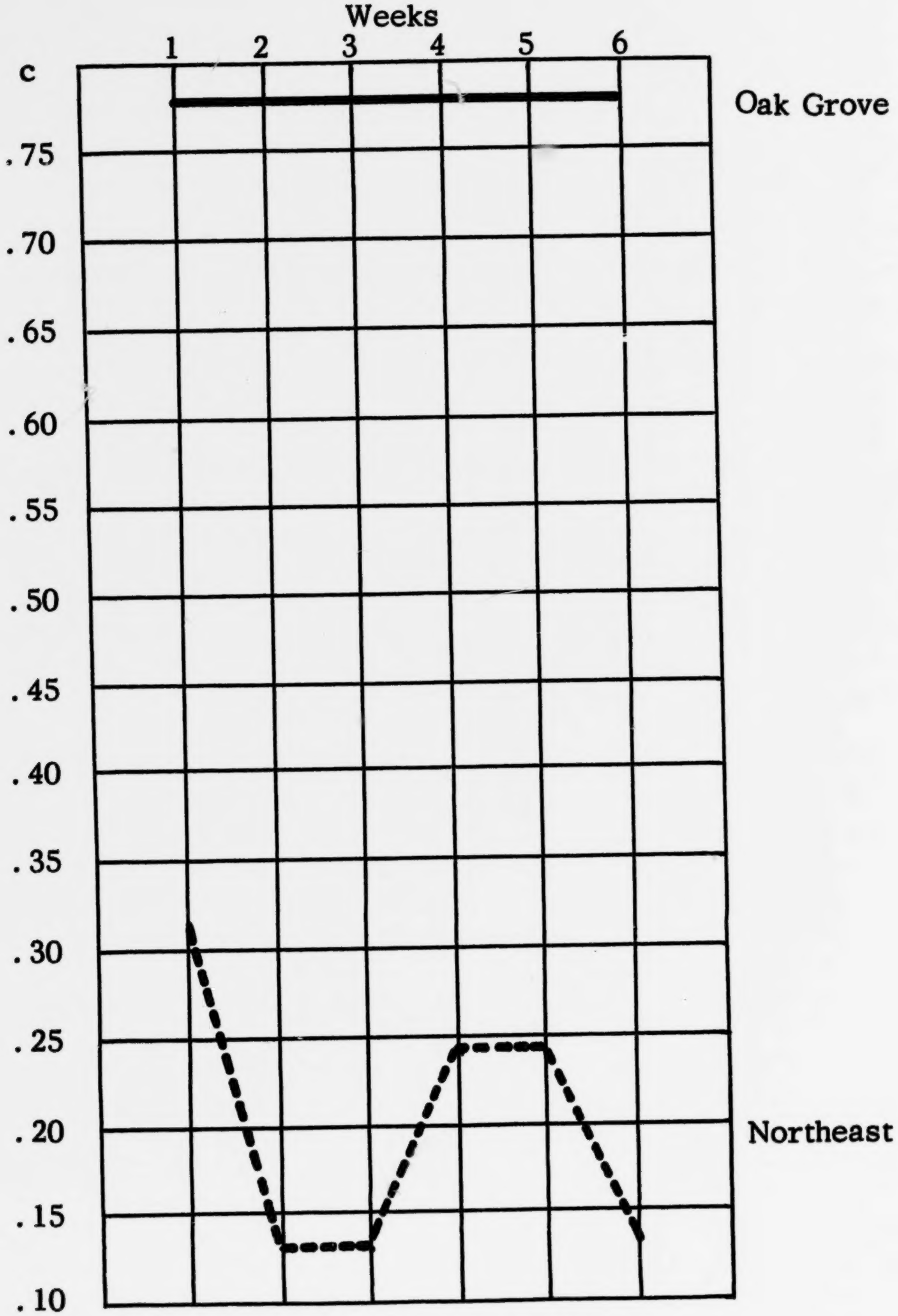


Figure VIII-2.--Weekly Comfort Indices of Oak Grove and Northeast, Summer 1962.

The testing program was modified in the summer of 1962 by eliminating that portion described as the Common Examination. The feeling was strongly expressed by the teaching personnel that the testing program required too much of the total summer school instructional time. The investigators, recognizing the merit of their position, reduced the battery to the Word Knowledge, Spelling and Language Usage sub-tests of the Metropolitan battery and the Pinellas Supplementary English Test for students enrolled in English. The tests for students enrolled in mathematics were not changed. To neither group was the Common Examination administered. Table VIII-12 presents the testing program for students enrolled in the 1962 summer school.

Table VIII-12. -- Testing Program, Summer 1962

Test	Sections	Student Group
English	Metropolitan Achievement subtests: 1. Word Knowledge 3. Spelling 4. Language Usage	English 7, 8, 9
	Pinellas Supplement subtest: 1. English	English 7, 8, 9
Mathematics	Metropolitan Achievement subtests: 6. Arithmetic Computation 7. Arithmetic Problem Solving and Concepts	Mathematics 7, 8, 9
	Pinellas Supplement subtest: 2. Mathematics	Mathematics 7, 8, 9

It should be noted that decisions as to which sub-tests might be eliminated were made on the basis of inter-correlations between sub-tests based upon previous administrations in Pinellas County. In those instances in which pairs of tests, such as Word Knowledge and Reading correlated very highly, one was eliminated. The reduced battery for students enrolled in the English course required approximately the same testing time as was required by the tests for students enrolled in mathematics.

The testing program was conducted under similar conditions and on identical days in both schools. These investigators know of no extraneous factors, such as general illness, that may have operated to produce differential effects in the two schools. The tests were scored by machine and results of neither pre-tests nor post-tests were made known to the teachers. The analyses reported in the following pages follow the form utilized in reporting the results for the summer of 1961.

The reader will recall that achievement was operationally defined as the difference between scores earned on the pre-and-post administration of these tests. Table VIII-13 reports differences in achievement gained by all students, grades 7-9 inclusive, for English and mathematics, in the climate controlled school and in the non-climate controlled school. Mean test scores, standard deviations and differences are reported in standard score units.

Table VIII-13. -- Analyses of Mean Scores by School and by Subject Test, Summer 1962

School	Test	N	Stat.	Pre-test	Post-test	Gain	Loss	Diff. OG-NE
Oak Grove	Metro. Lang.	48	Mean	147.62	156.52	8.90		
			S.D.	25.17	27.02			+1.80
Northeast		71	Mean	149.10	156.20	7.10		
			S.D.	20.49	20.42			
Oak Grove	Pinellas English	48	Mean	43.25	47.33	4.08		
			S.D.	8.63	7.85			-0.17
Northeast		71	Mean	45.14	49.39	4.25		
			S.D.	6.19	7.58			
Oak Grove	Metro. Arith.	23	Mean	96.87	103.00	6.13		
			S.D.	16.34	17.53			+2.00
Northeast		46	Mean	106.87	111.00	4.13		
			S.D.	19.40	18.60			
Oak Grove	Pinellas Math.	23	Mean	43.91	44.26	0.35		
			S.D.	9.63	10.48			-2.26
Northeast		46	Mean	48.09	50.70	2.61		
			S.D.	11.24	9.92			

On each of the four tests both schools showed a gain in achievement in English and mathematics. However, the data is not conclusive as to which school had the greater gain, in that the climate controlled school performed better on the Metropolitan Language and Arithmetic tests and the non-climate controlled school on the Pinellas Supplementary English and Mathematics tests.

Beginning with Table VIII-14, a series of four tables report data by grade levels and by schools, for the Metropolitan and Pinellas English and mathematics tests. For each of the four tests the mean pre-and-post-test scores, and differences in achievement are reported in standard score units.

Table VIII-14 reports the results of the Metropolitan English Test, and Table VIII-15 the findings for the Pinellas Supplementary English Test. Oak Grove and Northeast seventh, eighth and ninth graders showed a gain in achievement on both the Metropolitan and Pinellas English Tests. It will be seen that on the Metropolitan English Test, the Oak Grove seventh and ninth graders exceeded Northeast's seventh and ninth graders but Northeast eighth graders surpassed the Oak Grove eighth grade students. The situation is just the reverse for the Pinellas Supplementary English Test. In this case, Northeast seventh and ninth graders gained more in achievement than did Oak Grove seventh and ninth grade students, and the eighth grade students at Northeast fell short of the achievement gain made by eighth grade students at Oak Grove. The test results in English lend no support to any claim of the superiority of one school over the other.

Data for the Metropolitan Arithmetic Test are reported in Table VIII-16, and for the Pinellas Supplementary Arithmetic Test in Table VIII-17. The seventh and eighth graders at Oak Grove and Northeast indicated gain in arithmetic achievement on both tests. The ninth grade students at both schools showed gains as measured by the Metropolitan tests. The students in this grade at Northeast also indicated a gain in terms of scores on the Pinellas Supplementary Arithmetic Test while those at Oak Grove showed a loss on this test. The Oak Grove students at all grade levels made the greater gains in achievement as shown by the results of the Metropolitan Arithmetic Test. However, just the opposite is true for the results of the Pinellas Supplementary Arithmetic Test, which indicates Northeast seventh, eighth, and ninth grade students had the greater achievement gain in mathematics. The results obtained by the comparison of mean gains in mathematics, as in English, do not support any claim of superiority of one school over the other.

Table VIII-14. -- Analyses of Mean Scores on Metropolitan English Test by Schools and by Grade Levels, Summer 1962.

School	Grade	N	Stat.	Pre-test	Post-test	Gain	Loss	Diff. OG-NE
Oak Grove	7	8	Mean	129.0	143.25	14.25		
			S.D.	22.41	26.22			+8.46
Northeast	7	23	Mean	132.48	138.27	5.79		
			S.D.	18.26	16.21			
Oak Grove	8	15	Mean	147.87	156.13	8.26		
			S.D.	29.33	28.42			-2.64
Northeast	8	10	Mean	150.20	161.10	10.90		
			S.D.	14.22	18.01			
Oak Grove	9	25	Mean	153.44	161.0	7.56		
			S.D.	22.07	26.05			+0.67
Northeast	9	38	Mean	158.87	165.76	6.89		
			S.D.	17.38	15.92			

Table VIII-15. -- Analyses of Mean Scores on Pinellas Supplementary English Test by Schools and by Grade Levels, Summer 1962.

School	Grade	N	Stat.	Pre-test	Post-test	Gain	Loss	Diff. OG-NE
Oak Grove	7	8	Mean	41.25	44.75	3.50		
			S.D.	8.51	8.94			-1.06
Northeast	7	23	Mean	41.09	45.65	4.56		
			S.D.	6.20	6.91			
Oak Grove	8	15	Mean	42.33	46.0	3.67		
			S.D.	10.47	8.80			+2.97
Northeast	8	10	Mean	46.10	46.80	.70		
			S.D.	6.33	5.75			
Oak Grove	9	25	Mean	44.44	48.96	4.52		
			S.D.	7.98	6.78			-0.48
Northeast	9	38	Mean	47.34	52.34	5.00		
			S.D.	4.72	7.27			

Table VIII-16. -- Analyses of Mean Scores on Metropolitan Arithmetic Test by Schools and by Grade Levels, Summer 1962.

School	Grade	N	Stat.	Pre-test	Post-test	Gain	Loss	Diff. OG-NE
Oak Grove	7	14	Mean	88.71	93.36	4.65		+0.15
			S. D.	13.58	11.21			
Northeast	7	8	Mean	91.25	95.75	4.50		
			S. D.	11.45	11.80			
Oak Grove	8	5	Mean	106.80	116.80	10.0		+6.17
			S. D.	6.04	9.12			
Northeast	8	18	Mean	97.78	101.61	3.83		
			S. D.	12.06	12.40			
Oak Grove	9	4	Mean	113.0	119.50	6.50		+2.25
			S. D.	19.02	21.99			
Northeast	9	20	Mean	121.30	125.55	4.25		
			S. D.	17.98	15.04			

Table VIII-17. -- Analyses of Mean Scores on Pinellas Supplementary Arithmetic Test by Schools and by Grade Levels, Summer 1962.

School	Grade	N	Stat.	Pre-test	Post-test	Gain	Loss	Diff. OG-NE
Oak Grove	7	14	Mean	39.0	39.43	0.43		-6.07
			S. D.	7.17	8.26			
Northeast	7	8	Mean	36.62	43.12	6.50		
			S. D.	14.24	9.40			
Oak Grove	8	5	Mean	49.40	50.00	0.60		-1.62
			S. D.	3.84	8.37			
Northeast	8	18	Mean	44.56	46.78	2.22		
			S. D.	6.29	4.35			
Oak Grove	9	4	Mean	54.25	54.00		0.25	-1.65
			S. D.	12.80	11.20			
Northeast	9	20	Mean	55.85	57.25	1.40		
			S. D.	9.22	9.98			

3. Summary and Conclusions - Summer Schools

The studies of mean gains in achievement in English and in mathematics during the summer of 1961 indicated that pupils in Oak Grove, the climate controlled school, made greater overall gains than did the pupils in Northeast, the non-climate controlled school. The superiority of Oak Grove over Northeast was indicated by every comparison made.

The same type of studies of pupil performance during the summer of 1962 can only be described as inconclusive. The comparisons produced differences in which approximately half favored one school and half the other. Many, if not most, of the obtained differences were small.

The net results are that pupils who conducted their studies in the climate controlled school gained more from their studies in English and mathematics during the first summer than did those who were enrolled in the non-climate controlled school, but the differences resulting from the second summer's study were null. This statement and the tabulated differences upon which it was based, may be interpreted in two ways. It may be stated that the climate controlled school equalled or surpassed the non-climate controlled school in terms of gain in overall achievement in English and mathematics during the two summer schools. Certainly the majority of the tabulated differences is favorable to the climate controlled school.

These investigators take the position that consistency between the outcomes of the two summers is a necessary condition for the making of any general statement about the relationship between gains in achievement in the two schools. On this basis, the data reported offer these investigators no basis upon which to generalize either of the year's results or even the combination of the two. In brief, the data presented failed to support the hypothesis that the comfort levels of these schools were positively related to student achievement.

In studies of this kind, the investigators often acquire information, insights, or impressions which are not objectively documented but may be of some value to themselves and to their readers. In this category, the present investigators wish to record their feelings that the fact that the pupils at Oak Grove, summer 1962, tended to excel in the Metropolitan tests possesses some significance. These tests were more comprehensive than were Pinellas Supplementary tests and hence made a more valid coverage of the subject matter of the courses. For this reason, it is possible that according equal weight to the two measures systematically underrated the actual achievement of Oak Grove, the school which scored the higher on the Metropolitan tests.

It is also the impression of these investigators that the summer school achievement in both schools was contaminated by differences in the motivation of individual students. Some students who have failed come to summer school with a determination to learn so they may receive credit. The motivation of others is near zero, if not negative. In small classes and over short periods the few more, or few less, unmotivated pupils will exert a much greater influence on outcomes than would the same number of individuals in a regular school year. The variability of grades in the same subject quite possibly was increased by the presence of differently motivated pupils. The apparently inconsistent results of the grade-by-grade analyses may be explained at least in part by this factor. The analyses involving all pupils were probably less influenced by this factor than were the analyses by grades.

C. Academic Year Studies

The general characteristics and general personnel and instructional practices of the Pinellas County Schools have been described in previous sections of this report. Specific information about the qualifications of the teachers in each of the three schools and about transfers of students and climatic conditions will be given in this section, as well as reports of achievement as measured each year.

1. The Academic Year 1961-62

The data in Table VIII-18 indicate that on the basis of the rank of their certificates, the faculty at Oak Grove would be considered to be the best prepared; the Tyrone faculty would rank second and the Pinellas Park faculty third in preparation. These rankings reflect the larger percentages in Ranks I and II and the relatively smaller percentage holding Rank III certificates. The only permit for a person to teach in a field in which he was not certificated was held by one teacher at Oak Grove.

Table VIII-18. -- Percentage of Teachers in Each School Holding Certificates of Specified Rank and Permit to Teach out of Field Academic Year 1961-62.

Certificate Rank	Percentage by Schools Oak Grove (N = 38)	Pinellas Park (N = 51)	Tyrone (N = 61)
I	2.63	0.00	1.64
II	39.48	19.61	31.15
III	57.89	80.39	67.21
Permit	2.63	0.00	0.00

The median chronological age and the mean years of experience in each of three categories are reported for each faculty in Table VIII-19. These data indicate that the median ages of the faculties ranged from 32. 23 to 36. 5 years, a total span of less than five years. The average public school teaching experience ranged from 5. 4 years to 8. 8 years, a total span of 3. 4 years. On the average, it may be said that each of these faculties was of an age and had attained sufficient experience to be well within the ranges in which the profession expects its most competent members to be found. These investigators would not expect the differences between schools in matters of age or experience to affect teaching competence.

Table VIII-19. -- Median Chronological Age and Mean Years of Experience of the Faculties, Academic Year 1961-62.

	Oak Grove (N = 38)	Pinellas Park (N = 51)	Tyrone (N = 61)
Chronological Age: Median Years	36. 5	32. 23	33. 83
Experience (Mean Years): Recognized, non-teaching	0. 84	0. 69	1. 13
Total Public School, In-County	2. 2	1. 6	3. 4
Total Public School	8. 8	5. 4	7. 7

The transfer of students between schools is permitted but carefully controlled by the county school administration. Authorized transfers are classified under six headings. Three of these have to do with family residence and family convenience and one with specific courses which may be offered in one school but not generally in the county. The distribution of such transfers into, or out of, the several schools of the county operates on a random basis. The two remaining reasons may be related to the academic or physical climates of each of the three schools under study and the number of such transfers is reported in Table VIII-20. These data indicate that for personal reasons one student transferred out of Oak Grove, one out of Pinellas Park, and three out of Tyrone (one of whom entered Pinellas Park). Each of the three schools received one or more students from other county schools for personal reasons. The total impact of transfer upon the several student bodies was small. Its distribution among the schools does not suggest differences related to

Table VIII-20. -- Number of Students Transferred, Academic Year 1961-62

Direction of Transfer	Reason for Transfer Authorized Personal	Health
Oak Grove to Pinellas Park		
Oak Grove to Tyrone		
Oak Grove to Other Schools	1	
Pinellas Park to Oak Grove		
Pinellas Park to Tyrone		
Pinellas Park to Other Schools	1	
Tyrone to Oak Grove		
Tyrone to Pinellas Park	1	
Tyrone to Other Schools	2	
Other Schools to Oak Grove	2	3
Other Schools to Pinellas Park	1	
Other Schools to Tyrone	3	

academic standards of the schools or to the personal conduct of any significant number of students. It should be noted that Oak Grove, the climate controlled school, received the three students by transfer for health reasons. While the transfer of these students was presumably of personal value to them, the three could hardly have affected the general academic ability of the student body.

The experimental treatment applied in this study was the control of the temperature and related humidity in one school, Oak Grove. The other two schools were heated, but not cooled, and the principal ventilation was obtained through open windows. Pinellas Park was equipped with ceiling exhaust fans in hallways. Tyrone had no mechanical ventilating equipment other than small room fans which the teachers used on a non-systematic basis.

The effect of the control of climate upon student comfort has been considered in other sections of this report. The comfort of students may be considered an intermediate variable, in terms of which the treatment may be described. Over the academic year 1961-62, the comfort level of Oak Grove, the climate controlled school was 0.856; of Pinellas Park 0.547; and of Tyrone 0.649. The method of derivation of these indices makes them general statements of the proportions of students who it was estimated would have indicated comfort throughout the year.

It was suggested that the distribution of levels of comfort on a weekly basis was an appropriate description of the treatment in terms of which its effect upon student achievement should be considered. Weekly comfort indices for each of the three schools were computed. The weekly mean outside temperatures at Oak Grove were also computed for reference. These are presented graphically in Figure VIII-3. The data presented indicate that the weekly comfort indices of Oak Grove varied about the annual index of 0. 856, the range being 0. 79-0. 90. There were no marked seasonal variations and no extended periods displaying low comfort levels.

The conditions of comfort in Pinellas Park, on the other hand, varied from 0. 25-0. 72 about its annual index of 0. 547. The first and last six weeks periods of the school year were uninterrupted periods of low comfort levels. The intervening 26 school weeks were marked by relatively wide variations of comfort levels. During the first twelve weeks there was a rather consistent tendency for the comfort levels to increase as the outside temperature decreased. From the thirteenth to the thirty-first week there appeared to be a tendency for the comfort levels of the classrooms to fluctuate inversely with fluctuations in the outside temperature. From the thirty-second week to the close of school,comfort decreased quite systematically as outside temperatures increased. The comfort conditions in Pinellas Park school were extremely uneven from week to week. It experienced no prolonged period of conditions which were good even for that school. At no time was the comfort level equivalent to the least comfortable condition experienced at Oak Grove.

Tyrone experienced a general comfort level of 0. 649 for the year. The comfort levels ranged from 0. 52 to 0. 71. During the first four weeks and during the last seven weeks the comfort levels were consistently below the year's index. Between these times, comfort varied rather narrowly about the annual index, being above that standard most of the time. At no time was the comfort level equivalent to the least comfortable condition experienced at Oak Grove.

These data indicate that on the basis of comfort, it could be inferred that the students at Oak Grove should show the greatest academic gain, those at Pinellas Park the least gain, and the students at Tyrone should occupy an intermediate position.

The measures of achievement reported in this section were derived from the results of the testing program conducted as part of the total study. Pretests were administered during the third week of school and post-tests during the third week preceding the close of school. These periods were selected as the earliest and latest times during which it was felt that the students' performance would not be influenced by the extraneous factors associated with opening and closing school.

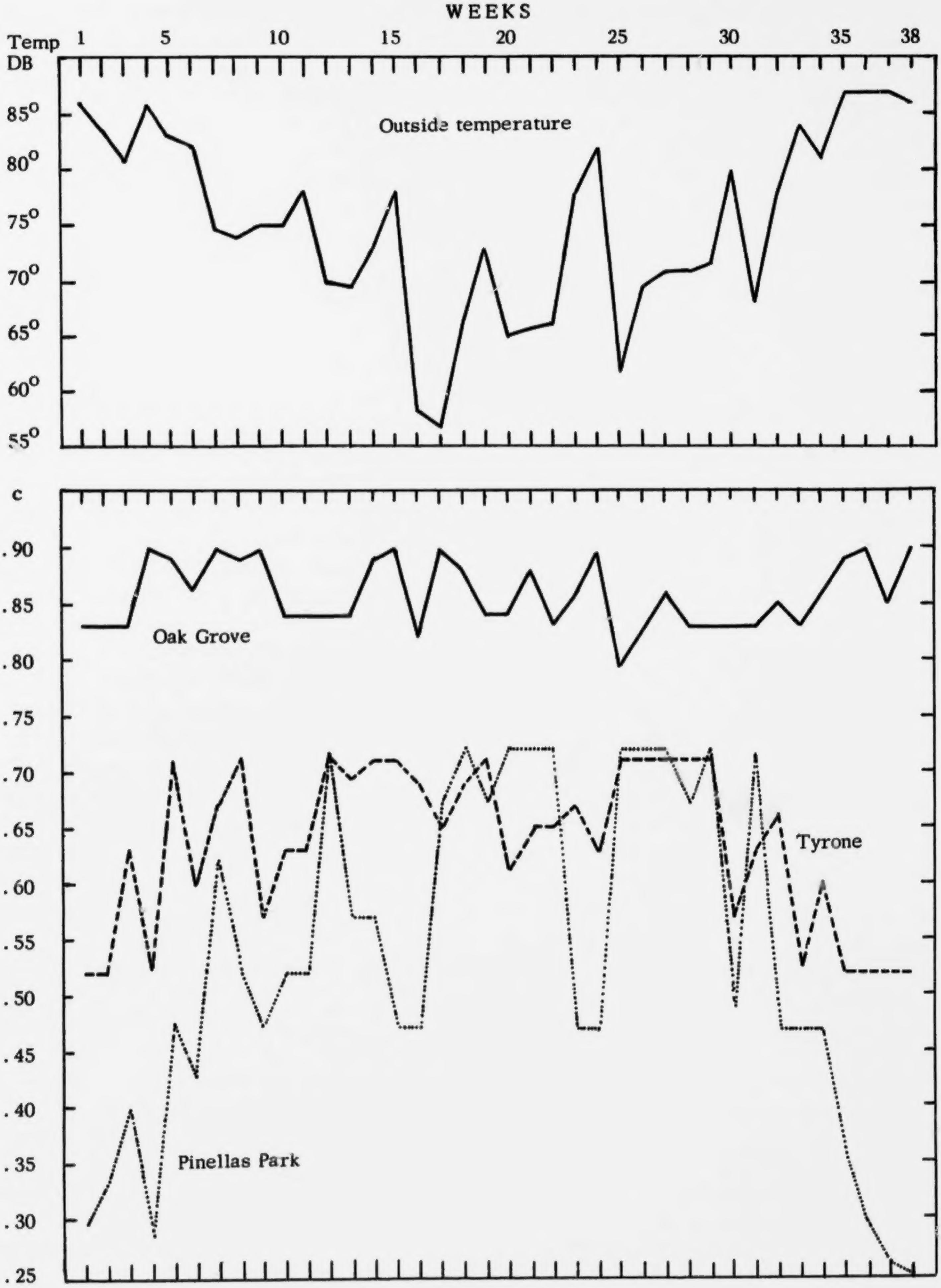


Figure VIII-3. -- Weekly Comfort Indices of the Three Schools and Outside Temperatures, Academic Year 1961-62.

The measures administered were sub-tests of alternate forms of the Metropolitan Achievement Tests. These included the tests of Word Knowledge, Reading, Spelling, Language Usage, Language Study Skills, Arithmetic Computation, Arithmetic Problem Solving and Concepts, Social Studies Information, Social Studies Study Skills, and Science. To these were added Pinellas Supplementary Tests in English, mathematics, social studies and science. Alternate forms of the Metropolitan tests were used for the pre-test and for the post-test, but the same form was repeated in the case of the Pinellas Supplementary Tests.

All tests were administered to all pupils present on the day of testing. However, the investigators disregarded the scores of all pupils who were not present, or who did not return scorable answer sheets for each section of both the pre-and-post tests. The scores of the few students who had transferred out of, and back into, these schools during the year were also disregarded. The effect of these policies was to restrict the population studied to those students who were enrolled, present and comprehensively examined at both the pre-and the post-testing sessions and to further limit this population to those whose entire year of instruction had been received in the school in which they took the pre-test. The number of such students is reported by grade and school in Table VIII-21. The grade sizes ranged from 173 to 434.

This number of students necessitated sectioning of classes and the distribution of sections among several teachers. The type of sectioning varied among the schools and among the subjects studied, being influenced by considerations of space for teaching, availability of teachers, educational philosophy and perhaps other factors. The net effect of the sectioning was probably that of reducing the impact of individual teachers, particular methods, and peer group influence upon the school-wide achievement of students.

Table VIII-21. -- Number of Students Included in Study of Achievement, Classified by School and Grade Within School, Academic Year 1961-62.

Grade	Oak Grove	Pinellas Park	Tyrone
7	201	288	376
8	173	289	373
9	195	229	434
Total	569	806	1183

The primary purpose of this study was to compare the achievement of students in the climate controlled school with that of students in each of two non-climate controlled schools. The achievement of the several student groups at the beginning and at the end of the school year is described in terms of their mean score and the standard deviation of the distribution of their scores. The difference between the mean end-of-year and beginning-of-year standard scores is used as the criterion measure of academic year achievement. The standard error of this difference is not reported because this statistic has meaning only in those cases in which statistical inference may be properly applied. The three schools were the primary groups and are considered first. The second consideration is the performance of each of the three grades, 7, 8, and 9, within schools. The logic of this approach is based upon the assumption that observed differences in achievement which had been caused by the treatment, control of the climate, should hold consistently from grade-to-grade within the schools.

The testing program included fourteen sub-tests, each of which was subject to variable errors of measurement and probably to varying degrees of validity, as measures of the content actually taught in the several sections of each of the four broad areas (English, mathematics, social studies and science). By chance alone the magnitude of such errors in one, or a few, sub-tests within schools might obscure small but systematic differences revealed by the remaining sub-tests in that school. For this reason the several sub-tests were not consolidated and comparisons were made in terms of the frequency with which the differences in mean gains in achievement favored one or the other of the two schools or situations being compared.[1]

The data in Table VIII-22 report number of students, the means and standard deviations of the distributions of pre-and-post test scores and the differences between the means for each test in each of the three schools. Each school gained in the achievement measured by each and every test. The standard scoring systems employed provided a range of 20-80. Eighty-three of the 84 obtained means fell within ten standard score points of 50, the midpoint of the range, and the remaining score deviated by 10. 20 points. The standard deviations of the distributions ranged from 7. 94 to 12. 66 score points. The data lend support to the position that the tests employed were appropriate and functional measures of academic achievement at the grade levels and for the populations involved in this study.

---

[1] A second approach to the description and comparison of achievement was based upon covariance analyses of samples of student test scores. The results are not reported because covariance requires assumptions of questionable validity in this study. The results of the covariance analysis agreed with those derived by analyses which did not require the making of assumptions of doubtful validity.

Table VIII-22. -- Pre-Test, Post-Test and Standard Score Differences on Each Test. Reported by Schools, Academic Year 1961-62.

		Pinellas Park (N=806)			Oak Grove (N=569)			Tyrone (N=1183)		
Test	Stat.	Pre	Post	Diff.	Pre	Post	Diff.	Pre	Post	Diff.
Word Knowledge	Mean	49.90	52.30	2.40	53.58	56.18	2.60	54.70	57.09	2.39
	S.D.	10.24	10.24		9.86	9.88		10.44	9.46	
Reading	Mean	47.84	52.70	4.86	51.42	54.97	3.55	52.60	57.33	4.73
	S.D.	10.41	10.56		10.82	10.43		10.18	9.70	
Spelling	Mean	47.30	51.70	4.40	52.09	55.75	3.66	54.70	56.59	1.89
	S.D.	10.66	11.29		10.98	11.25		11.04	10.29	
Language	Mean	46.80	51.50	4.70	50.90	55.46	4.56	51.71	54.65	2.94
	S.D.	9.74	10.30		10.42	12.04		10.01	11.27	
Language Study Skills	Mean	47.20	52.10	4.90	49.47	55.19	5.72	49.38	55.77	6.39
	S.D.	10.80	11.39		10.49	12.66		10.10	10.58	
Arithmetic Computation	Mean	49.10	54.10	5.00	50.88	57.11	6.23	52.90	58.16	5.26
	S.D.	10.39	10.91		10.70	10.68		11.99	11.19	
Arithmetic Problem Solving	Mean	49.40	53.00	3.60	51.32	56.09	4.77	54.04	56.21	2.17
	S.D.	9.63	10.43		10.31	10.08		10.29	10.12	
Social Studies Information	Mean	47.90	49.50	1.60	51.26	54.72	3.46	52.14	56.57	4.43
	S.D.	9.54	10.64		10.00	10.57		10.75	10.06	
Social Studies Skills	Mean	49.10	50.20	1.10	50.31	53.17	2.86	52.00	54.72	2.72
	S.D.	10.64	9.99		10.88	9.84		10.68	9.24	
Science	Mean	49.00	51.80	2.80	51.81	55.92	4.11	51.74	57.59	5.85
	S.D.	10.50	11.31		11.71	11.27		10.64	9.83	
Pinellas English	Mean	42.30	44.90	2.60	44.31	50.00	5.69	45.70	49.69	3.99
	S.D.	7.94	8.53		9.46	10.07		9.01	9.63	
Pinellas Mathematics	Mean	39.80	45.50	5.70	43.43	49.64	6.21	42.97	49.81	6.84
	S.D.	10.13	10.17		10.26	9.81		10.22	10.41	
Pinellas Social Studies	Mean	41.50	47.70	6.20	44.95	51.66	6.71	45.55	51.77	6.22
	S.D.	9.33	10.02		10.40	10.07		10.07	10.40	
Pinellas Science	Mean	41.10	43.30	2.20	44.01	46.46	2.45	45.22	47.62	2.40
	S.D.	9.62	10.90		11.09	10.61		9.98	10.67	

The differences between the mean pre-and-post test scores represent gains in achievement between testing dates. The differences representing gains in achievement reported in the preceding table have been consolidated into Table VIII-23. The differences between the gains realized in Oak Grove and in each of the other schools are reported as the second row of data with each test. A positive sign attached to a difference indicates that the climate controlled school exceeded the other in measured achievement and a negative sign indicates that Oak Grove did less well than did the other school. The reader will note that these latter differences tend to be quite small, individually. The last two rows report the number of tests in which Oak Grove excelled and the number of tests in which Oak Grove did less well than did each of the other schools.

Table VIII-23. -- Mean Standard Score Gains by Schools and Differences Between Mean Gain of Oak Grove and Each Other School on Each Test, Academic Year 1961-62.

	Pinellas Park (N=806)		Oak Grove (N=569)		Tyrone (N=1183)
Word Knowledge	2.40		2.60		2.39
Diff. (Oak Grove-Other)		+0.20		+0.21	
Reading	4.86		3.55		4.73
Difference		-1.31		-1.18	
Spelling	4.40		3.66		1.89
Difference		-0.74		+1.77	
Language	4.70		4.56		2.94
Difference		-0.14		+1.62	
Language Study Skills	4.90		5.72		6.39
Difference		+0.82		-0.67	
Arithmetic Computation	5.00		6.23		5.26
Difference		+1.23		+0.97	
Arithmetic Problem	3.60		4.77		2.17
Difference		+1.17		+2.60	
Social Studies Information	1.60		3.46		4.43
Difference		+1.86		-0.97	
Social Studies Study Skills	1.10		2.86		2.72
Difference		+1.76		+0.14	
Science	2.80		4.11		5.85
Difference		+1.31		-1.74	
Pinellas English	2.60		5.69		3.99
Difference		+3.09		+1.70	
Pinellas Mathematics	5.70		6.21		6.84
Difference		+0.51		-0.63	
Pinellas Social Studies	6.20		6.71		6.22
Difference		+0.51		+0.49	
Pinellas Science	2.20		2.45		2.40
Difference		+0.25		+0.05	
Number Positive Differences		11		9	
Number Negative Differences		3		5	

The data reported in Table VIII-23 indicate that for the year 1961-62, the gains in Oak Grove exceeded those in Pinellas Park 11 out of 14 times and exceeded those in Tyrone 9 out of 14 times. On the remaining tests Oak Grove did less well than did Pinellas Park and Tyrone.

The obtained differences between schools may be considered to be the algebraic sum of two elements, namely systematic differences over all grades within schools and variable differences by grades within schools. The latter element, variable differences by grades, theoretically would have been the result of factors other than climate control because there is no basis for the belief that climate control would have been more, or less, effective for one grade than for another. This type of variability probably resulted from differences in the ability or motivation of the several classes and/or from differences in the effectiveness of instruction. Within the limitations of this case study, the best evidence available - that the obtained differences between schools resulted from a systematic treatment and not from variable influences - is that of the tendency for the direction of differences between schools to be consistent grade by grade.

The data in Tables VIII-24, VIII-25 and VIII-26 report the mean pre-test and post-test scores, the standard deviations of each distribution and the mean gains for each test in each school for students in grades seven, eight, and nine, respectively. These data provide two additional checks upon the quality and appropriateness of the tests of achievement utilized in this study. The first of these is the consistency with which students in successively more advanced grades scored higher than did those in the grade immediately lower. This may be expressed as the percentage of the instances in which the following relation holds:

Grade 8 > Grade 7

Grade 9 > Grade 8

The condition, Grade 9 > Grade 7, will not be considered because the difference it expresses is too large to be of any value as a standard by which to judge the appropriateness of achievement tests at this level and in these subjects.

Table VIII-24. -- Pre-Test, Post-Test and Standard Score Differences on Each Test. Grade Seven Reported by Schools, Academic Year 1961-62.

		Pinellas Park (N=288)			Oak Grove (N=201)			Tyrone (N=376)		
Test	Stat.	Pre	Post	Diff.	Pre	Post	Diff.	Pre	Post	Diff.
Word Knowledge	Mean	46.40	49.40	3.00	48.69	52.15	3.46	49.63	53.11	3.48
	S.D.	8.96	9.22		8.52	8.63		8.49	9.23	
Reading	Mean	44.50	49.40	4.90	47.26	50.87	3.61	47.90	53.15	5.25
	S.D.	10.22	10.02		9.97	9.34		9.66	9.53	
Spelling	Mean	42.70	49.10	6.40	45.61	50.96	5.35	45.99	52.09	6.10
	S.D.	8.48	11.10		8.69	10.68		9.08	9.31	
Language	Mean	42.40	48.20	5.80	45.49	50.44	4.95	46.37	50.11	3.74
	S.D.	7.95	9.49		8.84	10.82		7.90	9.62	
Language Study Skills	Mean	46.90	49.80	2.90	48.35	53.20	4.85	47.83	52.19	4.36
	S.D.	10.78	11.46		11.83	12.69		10.99	10.18	
Arithmetic Computation	Mean	43.40	50.60	7.20	44.54	51.80	7.26	44.46	53.24	8.64
	S.D.	7.26	9.97		7.70	9.05		7.79	9.82	
Ari[illegible]etic Problem Solving	Mean	45.10	49.70	4.60	46.35	51.20	4.85	48.20	51.35	3.15
	S.D.	7.76	9.57		8.80	8.62		7.43	8.82	
Social Studies Information	Mean	44.07	47.00	2.93	46.56	51.10	4.54	46.80	52.48	5.68
	S.D.	8.97	9.91		8.75	9.78		9.73	9.32	
Social Studies Skills	Mean	45.90	48.60	2.70	46.23	50.42	4.19	47.91	51.85	3.94
	S.D.	9.49	9.41		10.77	9.44		9.52	8.42	
Science	Mean	45.40	49.60	4.20	46.13	52.18	6.05	46.78	53.98	7.70
	S.D.	10.04	10.57		9.45	9.83		9.46	9.05	
Pinellas English	Mean	39.80	42.30	2.50	39.74	42.80	3.06	41.96	45.70	3.74
	S.D.	6.77	7.81		8.98	8.48		7.46	7.33	
Pinellas Mathematics	Mean	34.30	40.50	6.20	36.30	45.05	8.75	36.02	44.11	8.09
	S.D.	8.97	8.63		8.64	8.00		8.45	8.60	
Pinellas Social Studies	Mean	39.20	45.20	6.00	39.53	48.26	8.73	40.98	48.92	7.90
	S.D.	8.81	9.09		9.66	8.99		8.92	8.88	
Pinellas Science	Mean	36.80	39.30	2.50	37.54	41.56	4.02	40.22	42.02	1.80
	S.D.	8.69	9.34		9.93	9.04		8.61	9.21	

Table VIII-25. -- Pre-Test, Post-Test and Standard Score Differences on Each Test. Grade Eight, Reported by Schools, Academic Year 1961-62.

		Pinellas Park (N=289)			Oak Grove (N=173)			Tyrone (N=373)		
Test	Stat.	Pre	Post	Diff.	Pre	Post	Diff.	Pre	Post	Diff.
Word Knowledge	Mean	49.40	51.20	1.80	52.24	55.75	3.51	54.70	56.80	2.10
	S.D.	9.66	10.45		8.92	10.03		9.45	9.29	
Reading	Mean	48.10	51.80	3.70	50.44	54.13	3.69	53.40	57.06	3.66
	S.D.	11.14	10.40		11.78	10.05		10.77	9.33	
Spelling	Mean	46.30	50.20	3.90	50.75	54.91	4.16	54.70	56.04	1.34
	S.D.	11.20	11.38		10.73	10.68		10.08	9.87	
Language	Mean	46.60	50.90	4.30	50.80	54.65	3.85	51.51	55.07	3.56
	S.D.	9.25	10.32		9.73	10.75		9.35	11.15	
Language Study Skills	Mean	48.90	51.00	2.10	51.61	52.82	1.21	51.76	55.18	3.42
	S.D.	11.68	11.84		11.76	12.97		11.12	10.56	
Arithmetic Computation	Mean	48.30	53.10	4.80	49.47	56.50	7.03	52.74	58.84	6.10
	S.D.	9.50	10.93		9.15	9.94		10.92	10.94	
Arithmetic Problem Solving	Mean	48.60	51.60	3.00	49.18	55.20	6.02	53.97	56.95	2.98
	S.D.	9.20	10.30		9.22	9.45		10.09	9.59	
Social Studies Information	Mean	47.90	48.90	1.00	52.17	55.02	2.85	52.41	56.66	4.25
	S.D.	8.55	10.93		9.69	10.21		10.14	10.27	
Social Studies Skills	Mean	49.00	48.90	-0.10	49.00	51.86	2.86	51.33	53.90	2.57
	S.D.	10.44	10.28		10.37	9.51		10.02	9.66	
Science	Mean	49.10	48.80	-0.30	52.76	53.55	0.79	52.58	55.13	2.55
	S.D.	10.60	11.43		10.86	10.71		10.44	9.32	
Pinellas English	Mean	41.60	44.70	3.10	44.42	49.28	4.86	44.67	49.64	4.97
	S.D.	7.83	8.78		7.86	9.23		8.50	10.05	
Pinellas Mathematics	Mean	39.60	45.90	6.30	44.08	49.55	5.47	42.82	48.70	5.88
	S.D.	8.97	9.51		7.76	9.66		8.65	9.77	
Pinellas Social Studies	Mean	40.70	46.10	5.40	45.01	50.34	5.33	43.73	48.91	5.18
	S.D.	8.58	9.44		8.22	9.09		9.47	9.79	
Pinellas Science	Mean	41.96	43.30	1.34	45.99	46.12	0.13	46.16	47.53	1.37
	S.D.	9.50	11.00		9.11	10.19		10.04	10.15	

Table VIII-26. -- Pre-Test, Post-Test and Standard Score Differences on Each Test. Grade Nine, Reported by Schools, Academic Year 1961-62.

Test	Stat.	Pinellas Park (N=229) Pre	Pinellas Park (N=229) Post	Pinellas Park (N=229) Diff.	Oak Grove (N=195) Pre	Oak Grove (N=195) Post	Oak Grove (N=195) Diff.	Tyrone (N=434) Pre	Tyrone (N=434) Post	Tyrone (N=434) Diff.
Word Knowledge	Mean S. D.	54.90 10.49	57.20 9.38	2.30	59.80 8.56	60.71 9.04	0.91	59.16 10.76	60.79 8.29	1.63
Reading	Mean S. D.	51.70 8.05	57.90 9.36	6.20	56.58 8.41	59.93 9.77	3.35	56.00 8.44	61.18 8.54	5.18
Spelling	Mean S. D.	54.20 10.13	56.90 9.56	2.70	59.96 8.05	61.37 9.76	1.41	59.20 10.61	60.93 9.66	1.73
Language	Mean S. D.	52.40 9.51	56.30 9.38	3.90	56.57 9.49	61.33 9.61	4.76	56.51 9.87	58.23 11.34	1.72
Language Study Skills	Mean S. D.	45.40 8.54	56.30 9.43	10.90	48.72 6.96	59.34 11.25	10.62	48.70 8.26	59.37 9.74	10.67
Arithmetic Computation	Mean S. D.	57.30 9.46	59.90 9.60	2.60	58.68 9.73	63.14 9.76	4.46	60.41 10.65	61.85 10.97	1.44
Arithmetic Problems	Mean S. D.	55.90 8.80	59.00 9.02	3.10	58.33 9.44	61.93 9.00	3.60	59.15 9.89	59.79 9.71	0.64
Social Studies Information	Mean S. D.	52.90 9.16	53.30 10.07	0.40	52.29 9.47	58.17 10.45	2.88	56.58 9.98	60.02 9.12	4.44
Social Studies Study Skills	Mean S. D.	53.20 11.38	53.90 9.36	0.70	55.68 9.12	57.18 9.20	1.50	56.14 10.51	57.92 8.55	1.78
Science	Mean S. D.	53.40 9.23	58.50 9.07	5.10	56.83 11.95	61.87 10.71	5.04	55.30 10.14	62.82 8.58	7.52
Pinellas English	Mean S. D.	46.20 7.97	48.40 7.84	2.20	48.93 8.97	54.98 9.01	6.05	49.82 8.85	53.19 9.69	3.37
Pinellas Mathematics	Mean S. D.	46.90 8.38	51.20 9.62	4.30	50.21 8.86	54.46 9.40	4.25	49.11 8.88	55.70 9.22	6.59
Pinellas Social Studies	Mean S. D.	46.70 8.60	52.90 9.96	6.20	50.57 9.90	56.32 10.30	5.75	51.06 8.90	56.71 10.29	5.65
Pinellas Science	Mean S. D.	45.40 8.61	48.40 10.48	3.00	47.99 10.68	51.81 9.93	3.82	48.76 9.26	52.54 9.89	3.78

The tabular data in Table VIII-27 indicate that in every school the scores on the pre-tests of eighth grade students exceeded those of students in the seventh grade. The scores on the pre-tests of ninth grade students exceeded those of eighth grade students on 13 of the 14 tests and the exception in every case was the language study skills test. The consistent reversal between eighth and ninth grade on this test suggests that the tests may be making a valid and reliable discrimination instead of reflecting variable errors of measurement. If, however, this possibility is discounted, the tests when applied prior to instruction discriminated grade levels with 96. 43% accuracy in each school.

Table VIII-27. -- Discrimination of Grade Levels of Pre-Tests and Post-Tests in Each of the Three Schools, Academic Year 1961-62.*

	Pinellas Park				Oak Grove				Tyrone			
	Pre-test		Post-test		Pre-test		Post-test		Pre-test		Post-test	
Relationship	8>7	9>8	8>7	9>8	8>7	9>8	8>7	9>8	8>7	9>8	8>7	9>8
f	14	13	13	14	14	13	13	14	14	13	13	14
Combined %	96. 43		96. 43		96. 43		96. 43		96. 43		96. 43	
Dev. Test	Lang. St. Skills		Science		Lang. St. Skills		Lang. St. Skills		Lang. St. Skills		Pinellas Soc. Stud.	

*The number of students involved in each grade are reported in Table VIII-21.

The post-test data in the same table indicate that in each school the tests showed the eighth grade students to be superior to the seventh grade students on 13 of the 14 tests. In this case the tests differed from school to school, which fact suggests that the failure to discriminate may have been produced by variable errors of measurement. The data further indicate that in every school all fourteen post-tests showed the ninth grade to be superior to the eighth grade in mean standard score units. Combining the two sets of inequalities in each school, the tabulations indicate that the tests when administered as post-tests discriminated grade levels with 96. 43% accuracy in each school.

The second check upon the quality and appropriateness of these tests is the consistency with which they indicated improvement in mean score following the period of instruction considered in this study. It is normally expected that the differences between pre-test and post-test scores for each test in each school at each grade level will be positive, indicating that in each case, the students learned as a result of instruction. The data reported in Table VIII-28 indicate that all 14 tests reflected improvement in the seventh and ninth grades in each school. The data

Table VIII-28. -- Number of Tests on Which Differences Between Pre-Test and Post-Test Mean Scores Were Positive and Negative, Classified by School and Grade, Academic Year 1961-62.

	Pinellas Park No. of Differences		Oak Grove No. of Differences		Tyrone No. of Differences	
	Positive	Negative	Positive	Negative	Positive	Negative
Grade 7	14	0	14	0	14	0
8	12	2	14	0	14	0
9	14	0	14	0	14	0
Total	40	2	42	0	42	0
% Disc.	95.24		100.00		100.00	

indicate that in Pinellas Park 12 of the 14 tests when applied at the eighth grade level reflected improvement and that all 14 tests reflected improvement at the eighth grade level in the other two schools. The percentages of discrimination reported in the last line of this table may be considered a summary. They show that in 95.24% of the possible instances the tests measured change in its expected direction in the Pinellas Park School and that they measured such change in 100% of the possible instances in each of the other two schools.

These analyses of test results suggest that the tests performed as measuring instruments in the manner in which they reasonably could be expected to perform. In other words, the consistency of their performance suggests that the reader may have a reasonable degree of confidence in their validity and reliability. It therefore seems appropriate to inquire about the consistency of the differences between the mean gains in measured achievement made by the students in Oak Grove and in each of the other schools, taken grade-by-grade.

The data in Table VIII-29 report by tests the mean gains made by seventh grade students in each of the three schools and the difference between each mean gain achieved by Oak Grove students and the similar gain achieved by Pinellas Park and Tyrone students, respectively. The positive sign in each instance indicates that the larger gain was achieved by Oak Grove students and the negative sign that the smaller gain was made by Oak Grove students.

Table VIII-29. -- Mean Seventh Grade Standard Score Gains by Schools and Differences Between Mean Gain of Oak Grove and Each Other School on Each Test, Academic Year 1961-62.

	Pinellas Park (N=288)		Oak Grove (N=201)		Tyrone (N=376)
Word Knowledge	3.00		3.46		3.48
Diff. (Oak Grove-Other)		+0.46		-0.02	
Reading	4.90		3.61		5.25
Difference		-1.39		-1.64	
Spelling	6.40		5.35		6.10
Difference		-1.05		-0.75	
Language	5.80		4.95		3.74
Difference		-0.85		+1.21	
Language Study Skills	2.90		4.85		4.36
Difference		+1.95		+0.49	
Arithmetic Computation	7.20		7.26		8.64
Difference		+0.06		-1.38	
Arithmetic Problem Solving	4.60		4.85		3.15
Difference		+0.25		+1.70	
Social Studies Information	2.93		4.54		5.68
Difference		+1.61		-1.14	
Social Studies Study Skills	2.70		4.19		3.94
Difference		+1.49		+0.25	
Science	4.20		6.05		7.70
Difference		+1.85		-1.65	
Pinellas English	2.50		3.06		3.74
Difference		+0.56		-0.68	
Pinellas Mathematics	6.20		8.75		8.09
Difference		+2.55		+0.66	
Pinellas Social Studies	6.00		8.73		7.90
Difference		+2.73		+0.83	
Pinellas Science	2.50		4.02		1.80
Difference		+1.52		+2.22	
Number Positive Differences		11		7	
Number Negative Differences		3		7	

Table VIII-30. -- Mean Eighth Grade Standard Score Gains by Schools and Differences Between Mean Gain of Oak Grove and Each Other School on Each Test, Academic Year 1961-62.

	Pinellas Park (N=289)		Oak Grove (N=173)		Tyrone (N=373)
Word Knowledge	1.80		3.51		2.10
Diff. (Oak Grove-Other)		+1.71		+1.41	
Reading	3.70		3.69		3.66
Difference		-0.01		+0.03	
Spelling	3.90		4.16		1.34
Difference		+0.26		+2.82	
Language	4.30		3.85		3.56
Difference		-0.45		+0.29	
Language Study Skills	2.10		1.21		3.42
Difference		-0.89		-2.21	
Arithmetic Computation	4.80		7.03		6.10
Difference		+2.23		+0.93	
Arithmetic Problem Solving	3.00		6.02		2.98
Difference		+3.02		+3.04	
Social Studies Information	1.00		2.85		4.25
Difference		+1.85		-1.40	
Social Studies Study Skills	-0.10		2.86		2.57
Difference		+2.96		+0.29	
Science	-0.30		0.79		2.55
Difference		+1.09		-1.76	
Pinellas English	3.10		4.86		4.97
Difference		+1.76		-0.11	
Pinellas Mathematics	6.30		5.47		5.88
Difference		-0.83		-0.41	
Pinellas Social Studies	5.40		5.33		5.18
Difference		-0.07		+0.15	
Pinellas Science	1.34		0.13		1.37
Difference		-1.21		-1.24	
Number Positive Differences		8		8	
Number Negative Differences		6		6	

Table VIII-31. -- Mean Ninth Grade Standard Score Gains by Schools and Differences Between Mean Gain of Oak Grove and Each Other School on Each Test, Academic Year 1961-62.

	Pinellas Park (N=229)		Oak Grove (N=195)		Tyrone (N=434)
Word Knowledge	2.30		0.91		1.63
Diff. (Oak Grove-Other)		-1.39		-0.72	
Reading	6.20		3.35		5.18
Difference		-2.85		-1.83	
Spelling	2.70		1.41		1.73
Difference		-1.29		-0.32	
Language	3.90		4.76		1.72
Difference		+0.86		+3.04	
Language Study Skills	10.90		10.62		10.67
Difference		-0.28		-0.05	
Arithmetic Computation	2.60		4.46		1.44
Difference		+1.86		+3.02	
Arithmetic Problem Solving	3.10		3.60		0.64
Difference		+0.50		+2.96	
Social Studies Information	0.40		2.88		4.44
Difference		+2.48		-1.56	
Social Studies Study Skills	0.70		1.50		1.78
Difference		+0.80		-0.28	
Science	5.10		5.04		7.52
Difference		-0.06		-2.48	
Pinellas English	2.20		6.05		3.37
Difference		+3.85		+2.68	
Pinellas Mathematics	4.30		4.25		6.59
Difference		-0.05		-2.34	
Pinellas Social Studies	6.20		5.75		5.65
Difference		-0.45		+0.10	
Pinellas Science	3.00		3.82		3.78
Difference		+0.82		+0.04	
Number Positive Differences		7		6	
Number Negative Differences		7		8	

The reader will note that a number of the individual differences are numerically small. In the absence of an appropriate error term, the investigators are unable to cast out some as insignificant and to attempt to generalize from the remaining significant differences. The only notation that is appropriate at this time is that at the seventh grade level, the measured gain in achievement of Oak Grove students exceeded that of the Pinellas Park students on 11 of the 14 tests and that of the Tyrone students on 7 of the same 14 tests. The measured gain in achievement of seventh grade students at Oak Grove was less than that of Pinellas Park seventh grade students on three tests and less than that of Tyrone seventh grade students on seven (exactly half) of the tests.

Similar analyses of obtained differences at the eighth grade level are presented in Table VIII-30 and at the ninth grade level in Table VIII-31. The reader will note that eighth grade achievement at Oak Grove exceeded that at each of the other schools in eight of the fourteen comparisons and was less than that in each of the other schools in six cases. At the ninth grade level, Oak Grove exceeded Pinellas Park in seven comparisons and Tyrone in six and was exceeded by Pinellas Park in seven and by Tyrone in eight.

The frequency data reported in each of the preceding tables have been consolidated in Table VIII-32. These data indicate that when all grades are included, achievement by Oak Grove students exceeded that in Pinellas Park in 26 of 42 possible comparisons and was less in the remaining 16 comparisons. They further indicate that Oak Grove and Tyrone each exceeded the other in 21, exactly half of the comparisons.

Table VIII-32. -- Summary of Frequencies of Signed Differences Between Oak Grove and Each of Two Other Schools in Tested Achievement, Academic Year 1961-62.

Grade	Oak Grove vs. Pinellas Park +	Oak Grove vs. Pinellas Park -	Oak Grove vs. Tyrone +	Oak Grove vs. Tyrone -
7	11	3	7	7
8	8	6	8	6
9	7	7	6	8
Totals	26	16	21	21

The results reported for the academic year 1961-62 will be considered in the summary in conjunction with those to be reported for the academic year 1962-63.

2. The Academic Year 1962-1963

The schools involved in this study experienced a turn-over of teachers between the academic years 1961-1962 and 1962-1963 for a number of reasons. It is normal for a portion of the women to withdraw from teaching and to assume full-time duties as a housewife. Others move from the community because of the transfer of their husbands. In a growing school system, a percentage of the experienced teachers is transferred to new schools as these are opened. These reasons are considered normal by the Pinellas County School System, and they account for most, if not all, of the shifts in the teacher personnel of these schools.

The distributions of the school faculties by ranks of certificates are shown in Table VIII-33. The data indicate that, on the basis of certification, the Oak Grove faculty ranked first, the Tyrone faculty second, and the Pinellas Park faculty third. The only instance of a teacher teaching out of his field of preparation was in Oak Grove, and this teacher was serving as librarian.

The distributions of the school faculties by the mean number of years of teaching experience is presented in Table VIII-34. These data indicate that the Tyrone teachers averaged the greatest length of in-county teaching experience and Oak Grove teachers averaged the greatest length of total teaching experience. The Pinellas Park faculty was the least experienced by both standards.

The data reported in Table VIII-35 indicate that a total of four students enrolled in these schools were granted transfers for personal reasons. The number of transfers granted does not indicate that these would cause any appreciable effect upon the student body of any of these schools. Oak Grove, the climate controlled school, received five students by transfer for health reasons. Such transfers are made only upon recommendation of the family physician. Apparently, the climate controlled building was thought to be beneficial for certain students. The addition of only five to the student body of Oak Grove probably had little or no effect upon the measured achievement of the school.

Over the academic year 1962-63, Oak Grove, the climate controlled school, attained a comfort index of 0. 854, which was practically equivalent to its previous year's record. Its weekly comfort levels depicted in Figure VIII-4 range from 0. 79-0. 90. It experienced comfort levels in the low eighties during twelve of the 39 school weeks and experienced one week of . 79. Its comfort level for 10 of the 39 weeks was 0. 90.

Table VIII-33. -- Percentage of Teachers in Each School Holding Certificates of Specified Rank and Permit to Teach Out of Field, Academic Year 1962-63.

Certificate Rank	Percentage by Schools Oak Grove (N = 35)	Pinellas Park (N = 52)	Tyrone (N = 63)
I	2.86		
II	37.14	21.15	34.92
III	60.00	78.85	65.08
Permit	2.86		

Table VIII-34. -- Mean Years of Teaching Experience of the Faculties, Academic Year 1962-63.

Type of Experience	Mean Years Oak Grove	Pinellas Park	Tyrone
Total Public School, In-County	1.8	1.3	2.5
Total Public School	9.0	5.6	7.8

Table VIII-35. -- Number of Students Transferred. Academic Year 1962-63

Direction of Transfer	Authorized Personal	Health
Oak Grove to other schools	1	
Pinellas Park to other schools	1	
Tyrone to other schools	0	
Other schools to Oak Grove	0	5
Other schools to Pinellas Park	1	
Other schools to Tyrone	1	

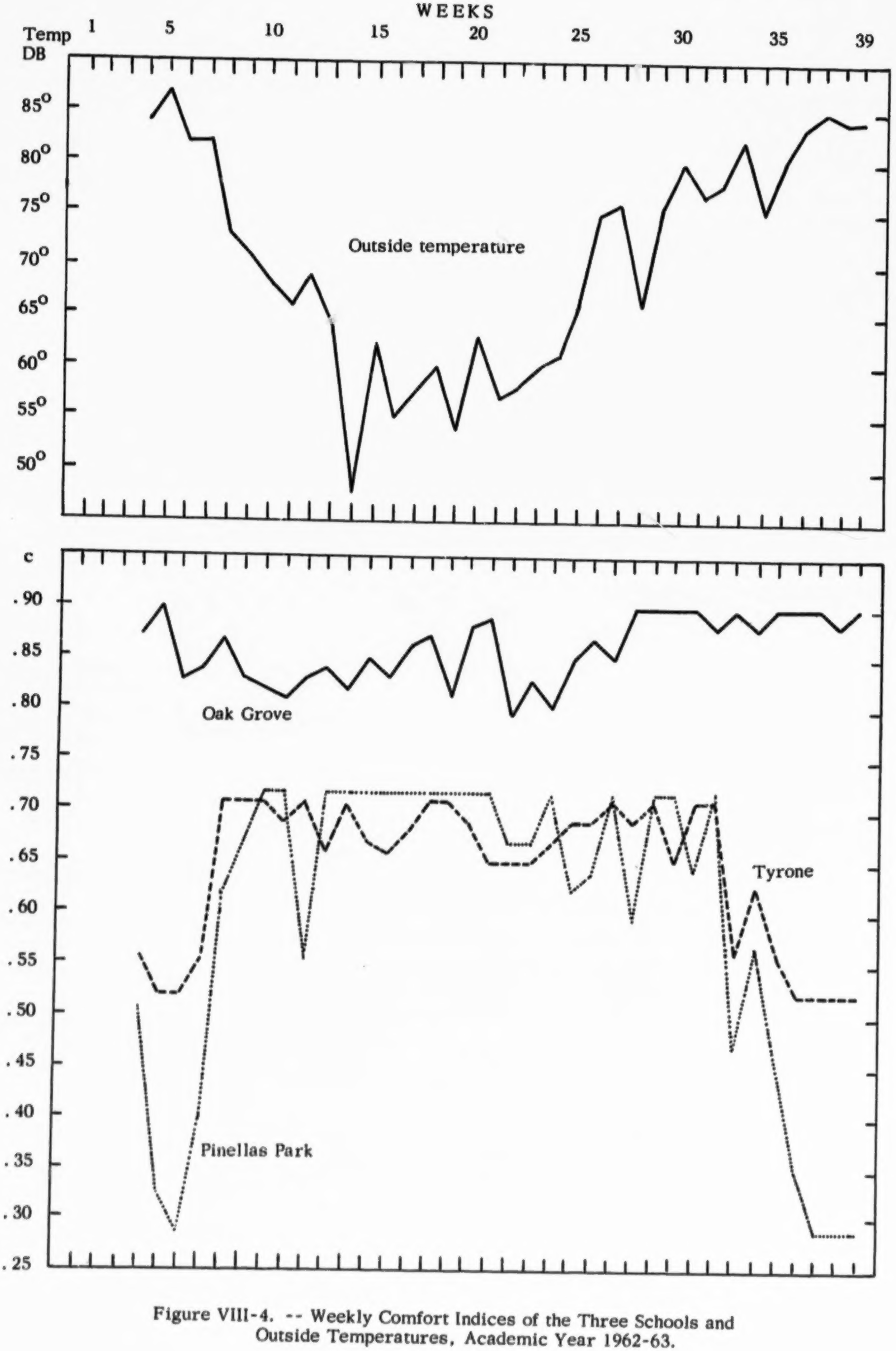


Figure VIII-4. -- Weekly Comfort Indices of the Three Schools and Outside Temperatures, Academic Year 1962-63.

Over the year 1962-63, Pinellas Park attained a comfort index of 0.589. This was approximately 0.04 higher than during the previous year. It should be noted that no records were available for the first three weeks, and this omission probably inflated the yearly index for both non-climate controlled schools. The best comfort conditions occurred between the tenth and thirty-second weeks. While there was variability during this interval, the conditions were generally the best experienced by this school. A sharp and consistent decrease in comfort occurred during the last five weeks of school. At no time did this school attain a comfort level equal to Oak Grove.

The annual comfort index of Tyrone for the academic year 1962-63 was 0.655. Had the first three weeks been included, it probably would have been no better than during the previous year. Its first seven and last five weeks were the least comfortable of the year. The interval from the eighth to the thirty-second weeks was generally good for this school, but tended to be somewhat less comfortable than was the same period at Pinellas Park. The relationships among the weekly comfort indices for the three schools lead to the inference, on the basis of comfort alone, that Oak Grove students should display greater achievement than either of the other schools and that the difference between the non-climate controlled schools should be minimal.

The testing program for the year 1962-63 was identical in substance to that of the previous year. Only the forms of the several tests differed. The number of students involved in each grade at each of the three schools is reported in Table VIII-36. Again, only those students who were present at both the pre-and-post testing periods are included.

Table VIII-36. -- Number of Students Included in Study of Achievement, Classified by School and Grade Within School, Academic Year 1962-63.

Grade	Oak Grove	Pinellas Park	Tyrone
7	190	297	374
8	223	260	408
9	206	262	396
Total	619	819	1178

The data in Table VIII-37 report the number of students, the means and standard deviations of the distributions of pre-and-post test scores and the differences between the means for each test in each of the three schools. All of the means fell within ten standard score units of 50, the midpoint of the standard score range. The first test, Word Knowledge, produced relatively small standard deviations on the pre-test, but an improvement is evident on the post-test. Its initial discriminating power was relatively weak. The standard deviations of all other tests ranged between 9.29 and 12.31 on scales having a possible range of 20-80. It is apparent that all tests were of suitable difficulty and all except the pre-test of Word Knowledge were good discriminators.

The differences between pre-and-post test scores represent gains in achievement. These differences have been consolidated in Table VIII-38. The differences between Oak Grove and each of the other schools are reported in the second row of data for each test. A positive sign attached to a difference indicates that Oak Grove, the climate controlled school, exceeded the other in measured achievement and a negative sign indicates that Oak Grove did less well than did the other. Again, many of the differences are small, individually. The last two rows of this table report the number of positive and of negative differences, respectively. The data reported in Table VIII-38 indicate that,for the academic year 1962-63, Oak Grove exceeded each of the other schools in the gains of achievement measured by 13 of the 14 tests. The single test on which the gain at Oak Grove was less than either of the other two schools was Reading.

Following the form of analysis of the previous year's data, each grade was treated separately. The pre-test and post-test means, and standard score differences are reported for grades 7, 8, and 9 in Tables VIII-39, VIII-40 and VIII-41, respectively. These follow the form of Table VIII-37 which reported the total by schools. The differences reported in Table VIII-39 have been consolidated in Table VIII-42. The second row of each test in this table reports the signed difference between the Oak Grove seventh grade and the seventh grade of each other school. The last two lines of this table report that for 13 of the 14 tests the achievement gain at the seventh grade level at Oak Grove was greater than at Pinellas Park. The gains in this grade at Oak Grove were greater than at Tyrone in 14 of the 14 possible cases.

Table VIII-43 presents similar data for the eighth grade. At this grade level the achievement of Oak Grove exceeded that of Pinellas Park in 10 of the 14 tests and exceeded that of Tyrone in 8 of the 14 tests.

Table VIII-44 presents the analysis of ninth grade gains. At this grade level, Oak Grove exceeded both Pinellas Park and Tyrone in 12 of the 14 tests. The results of the achievement study for the academic year 1962-63 will be further summarized and compared with those for the previous year.

Table VIII-37. -- Pre-Test, Post-Test and Standard Scored Differences on Each Test. Reported by Schools, Academic Year 1962-63.

		Pinellas Park (N=819)			Oak Grove (N=619)			Tyrone (N=1178)		
Test	Stat.	Pre	Post	Diff.	Pre	Post	Diff.	Pre	Post	Diff.
Word Knowledge	Mean	43.71	54.38	10.67	45.63	58.01	12.38	45.61	57.84	12.23
	S.D.	5.47	9.54		3.24	8.87		3.66	10.60	
Reading	Mean	48.58	53.06	4.48	52.97	56.64	3.67	52.43	56.85	4.42
	S.D.	11.10	11.45		9.77	10.69		10.22	11.20	
Spelling	Mean	48.73	52.27	3.54	52.50	57.82	5.32	53.03	56.43	3.40
	S.D.	10.95	11.23		10.78	10.65		10.22	10.20	
Language Usage	Mean	47.87	50.96	3.09	50.59	58.73	8.14	50.92	55.89	4.97
	S.D.	10.29	10.71		11.14	11.52		10.32	10.26	
Language Study Skills	Mean	50.38	52.01	1.63	52.85	55.95	3.10	52.58	55.59	3.01
	S.D.	10.94	11.83		11.10	11.35		10.88	12.31	
Arithmetic Computation	Mean	49.72	53.76	4.04	52.58	57.52	4.94	53.05	56.44	3.39
	S.D.	10.92	11.24		10.80	10.86		11.37	11.53	
Arithmetic Problem Solving	Mean	50.00	52.98	2.98	52.52	56.97	4.45	53.71	56.56	2.85
	S.D.	10.32	10.52		9.97	9.67		10.15	10.88	
Social Studies Information	Mean	49.47	52.98	3.51	51.90	56.21	4.31	52.34	55.24	2.90
	S.D.	10.03	10.57		10.98	10.31		10.82	10.95	
Social Studies Skills	Mean	49.18	50.89	1.71	51.31	54.94	3.63	51.36	53.79	2.43
	S.D.	10.19	11.21		10.18	10.13		9.86	10.58	
Science	Mean	50.40	53.23	2.83	51.91	56.55	4.64	52.74	55.83	3.09
	S.D.	10.63	11.57		10.84	10.66		10.35	10.60	
Pinellas English	Mean	43.32	45.69	2.37	46.15	54.16	8.01	46.39	49.35	2.96
	S.D.	9.11	9.51		9.29	11.35		10.22	9.37	
Pinellas Mathematics	Mean	40.31	46.67	6.36	44.31	50.94	6.63	43.85	49.72	5.87
	S.D.	10.87	10.73		9.94	9.94		10.53	11.12	
Pinellas Social Studies	Mean	41.84	45.30	3.46	45.72	49.53	3.81	45.08	48.95	2.87
	S.D.	10.02	10.19		9.56	11.52		9.96	10.63	
Pinellas Science	Mean	41.46	45.85	4.39	45.32	52.11	6.79	45.89	50.65	4.76
	S.D.	10.92	10.91		10.51	10.14		10.46	10.40	

Table VIII-38. -- Mean Standard Score Gains by Schools and Differences Between Mean Gain of Oak Grove and Each Other School on Each Test, Academic Year 1962-63.

	Pinellas Park (N=819)		Oak Grove (N=619)		Tyrone (N=1178)
Word Knowledge	10. 67		12. 38		12. 23
Diff. (Oak Grove-Other)		+1. 71		+0. 15	
Reading	4. 48		3. 67		4. 42
Difference		-0. 81		-0. 75	
Spelling	3. 54		5. 32		3. 40
Difference		+1. 78		+1. 92	
Language Usage	3. 09		8. 14		4. 97
Difference		+5. 05		+3. 17	
Language Study Skills	1. 63		3. 10		3. 01
Difference		+1. 49		+0. 09	
Arith. Computation	4. 04		4. 94		3. 39
Difference		+0. 90		+1. 55	
Arith. Problem Solving	2. 98		4. 45		2. 85
Difference		+1. 47		+1. 60	
Social Study Information	3. 51		4. 31		2. 90
Difference		+0. 80		+1. 41	
Social Study Skills	1. 71		3. 63		2. 43
Difference		+1. 92		+1. 20	
Science	2. 83		4. 64		3. 09
Difference		+1. 81		+1. 55	
Pinellas English	2. 37		8. 01		2. 96
Difference		+5. 64		+5. 05	
Pinellas Mathematics	6. 36		6. 63		5. 87
Difference		+0. 27		+0. 76	
Pinellas Social Study	3. 46		3. 81		2. 87
Difference		+0. 35		+0. 94	
Pinellas Science	4. 39		6. 79		4. 76
Difference		+2. 40		+2. 03	
Number Positive Differences		13		13	
Number Negative Differences		1		1	

Table VIII-39. -- Pre-Test, Post-Test and Standard Score Differences on Each Test. Grade Seven, Reported by Schools, Academic Year 1962-63.

		Pinellas Park (N=297)			Oak Grove (N=190)			Tyrone (N=374)		
Test	Stat.	Pre	Post	Diff.	Pre	Post	Diff.	Pre	Post	Diff.
Word Knowledge	Mean	41.66	51.28	9.62	44.59	54.97	10.38	44.22	54.09	9.87
	S.D.	6.60	8.74		4.18	7.81		5.12	8.64	
Reading	Mean	43.95	49.11	5.16	48.27	53.38	5.11	47.81	52.71	4.90
	S.D.	10.37	10.69		9.20	10.20		9.58	11.02	
Spelling	Mean	43.63	48.79	5.16	47.70	55.04	7.34	47.75	52.50	4.75
	S.D.	10.36	10.70		9.72	9.77		9.29	9.30	
Language Usage	Mean	43.54	46.47	2.93	45.09	55.03	9.94	45.89	51.95	6.06
	S.D.	9.28	9.30		8.93	10.22		9.28	8.83	
Language Study Skills	Mean	46.41	49.40	2.99	49.05	53.21	4.16	48.84	52.58	3.74
	S.D.	9.94	11.33		9.82	11.24		10.49	11.38	
Arithmetic Computation	Mean	42.26	48.60	6.34	45.23	52.24	7.01	44.81	50.66	5.85
	S.D.	6.39	9.72		7.29	9.76		7.18	10.31	
Arithmetic Problem Solving	Mean	44.67	48.63	3.96	46.73	53.08	6.35	47.16	50.91	3.75
	S.D.	7.71	8.84		8.03	9.09		7.72	9.88	
Social Studies	Mean	46.05	48.83	2.78	47.39	52.79	5.40	48.37	50.56	2.19
	S.D.	9.81	9.55		9.98	9.43		10.33	9.42	
Social Studies Skills	Mean	45.83	48.40	2.57	48.15	53.41	5.26	47.57	50.28	2.71
	S.D.	9.56	10.39		10.08	9.61		9.11	10.23	
Science	Mean	46.50	50.48	3.98	48.03	53.71	5.68	47.98	52.65	4.67
	S.D.	8.77	10.11		8.53	9.93		9.00	10.04	
Pinellas English	Mean	41.29	42.40	1.11	42.37	49.65	7.28	43.27	45.59	2.32
	S.D.	8.30	8.33		7.59	9.41		7.27	11.02	
Pinellas Mathematics	Mean	33.69	41.58	7.89	37.12	46.55	9.43	36.26	42.31	6.05
	S.D.	8.97	8.47		7.92	8.19		8.67	9.02	
Pinellas Social Studies	Mean	37.84	41.39	3.55	41.17	45.89	4.72	40.68	43.45	2.77
	S.D.	8.91	8.29		8.43	7.35		9.09	8.93	
Pinellas Science	Mean	36.41	43.04	6.63	39.85	52.57	12.72	40.16	48.16	8.00
	S.D.	9.87	9.98		9.60	9.28		9.13	9.70	

Table VIII-40. -- Pre-Test, Post-Test and Standard Score Differences on Each Test. Grade Eight, Reported by Schools, Academic Year 1962-63

		Pinellas Park (N=260)			Oak Grove (N=223)			Tyrone (N=408)		
Test	Stat.	Pre	Post	Diff.	Pre	Post	Diff.	Pre	Post	Diff.
Word Knowledge	Mean	43.58	54.28	10.70	45.69	57.50	11.81	45.88	58.05	12.17
	S.D.	5.27	9.17		3.14	9.15		2.99	9.22	
Reading	Mean	50.03	53.29	3.26	53.55	55.19	1.64	53.93	56.17	2.24
	S.D.	11.87	11.14		10.25	10.23		10.35	11.14	
Spelling	Mean	48.42	51.62	3.40	52.16	56.39	4.23	53.25	56.44	3.19
	S.D.	10.90	11.17		11.04	10.60		9.90	10.32	
Language Usage	Mean	48.12	50.70	2.58	49.68	57.68	8.00	50.67	55.72	5.05
	S.D.	10.00	10.13		10.44	11.16		9.41	10.04	
Language Study Skills	Mean	50.37	51.12	0.75	52.61	55.02	2.41	51.89	53.50	2.61
	S.D.	10.87	12.41		11.29	10.96		10.78	13.81	
Arithmetic Computation	Mean	50.77	54.57	3.80	54.01	57.45	3.44	53.86	58.01	4.15
	S.D.	10.86	11.38		10.14	10.29		10.39	11.02	
Arithmetic Problem Solving	Mean	49.43	52.40	2.97	52.81	56.89	4.08	54.46	57.52	3.06
	S.D.	9.71	10.37		9.02	9.76		9.06	10.35	
Social Studies	Mean	49.78	53.48	3.70	51.57	55.83	4.26	52.11	55.30	3.19
	S.D.	9.66	10.64		9.96	10.22		10.11	10.71	
Social Studies Skills	Mean	50.27	49.63	-0.64	51.55	53.85	2.30	51.96	53.28	1.32
	S.D.	10.31	11.36		10.31	10.67		9.49	10.37	
Science	Mean	51.90	51.10	-0.80	52.39	55.09	2.70	54.79	54.42	-0.37
	S.D.	11.23	12.06		10.57	10.71		9.49	10.26	
Pinellas English	Mean	41.03	45.18	4.15	45.37	53.29	7.92	46.65	49.27	3.62
	S.D.	8.67	9.16		10.25	10.14		7.97	8.99	
Pinellas Mathematics	Mean	41.02	47.20	6.18	45.32	50.43	5.11	44.78	50.87	6.09
	S.D.	8.96	9.82		11.04	9.94		8.38	9.36	
Pinellas Social Studies	Mean	41.31	45.51	4.20	45.38	48.38	3.00	44.69	49.76	5.07
	S.D.	9.29	10.08		10.44	10.11		8.73	10.13	
Pinellas Science	Mean	42.37	43.44	1.07	46.47	48.70	2.23	47.42	48.53	1.09
	S.D.	10.61	10.34		10.23	10.49		9.81	9.97	

Table VIII-41. -- Pre-Test, Post-Test and Standard Score Differences on Each Test. Grade Nine, Reported by Schools, Academic Year 1962-63.

		Pinellas Park (N=262)			Oak Grove (N=206)			Tyrone (N=396)		
Test	Stat.	Pre	Post	Diff.	Pre	Post	Diff.	Pre	Post	Diff.
Word Knowledge	Mean	46.14	57.98	11.84	46.50	61.36	14.86	46.66	61.15	14.49
	S.D.	2.41	9.52		1.71	8.35		1.68	8.45	
Reading	Mean	52.37	57.32	4.95	56.67	61.21	4.54	55.56	61.45	5.89
	S.D.	8.92	11.01		7.78	10.07		9.03	9.64	
Spelling	Mean	54.82	56.68	1.86	57.30	61.91	4.61	57.80	60.13	2.33
	S.D.	8.27	10.35		9.27	10.24		8.90	9.46	
Language Usages	Mean	52.52	56.32	3.80	56.64	63.28	6.64	55.93	59.79	3.86
	S.D.	9.54	10.34		10.78	11.53		9.77	10.28	
Language Study Skills	Mean	54.88	55.85	0.97	56.63	59.49	2.86	56.83	60.60	3.77
	S.D.	10.32	10.78		10.75	10.95		9.83	9.69	
Arithmetic Computation	Mean	57.15	58.80	1.65	58.40	62.47	4.07	60.00	60.29	0.29
	S.D.	9.49	10.14		10.21	9.83		10.56	10.99	
Arithmetic Problem Solving	Mean	56.61	58.48	1.87	57.54	60.64	3.10	59.11	60.91	1.80
	S.D.	9.79	9.91		9.75	8.60		9.75	9.97	
Social Studies	Mean	53.02	57.19	4.17	56.42	59.77	3.35	56.35	59.59	3.24
	S.D.	9.32	9.79		11.11	10.03		10.56	10.74	
Social Studies Skills	Mean	51.89	54.95	3.06	53.98	57.53	3.55	54.30	57.64	3.34
	S.D.	9.70	10.82		9.27	9.48		9.78	9.83	
Science	Mean	53.34	58.47	5.13	54.97	60.76	5.79	55.14	60.27	5.13
	S.D.	10.61	10.83		11.90	9.93		10.86	9.96	
Pinellas English	Mean	47.90	49.92	2.02	50.47	59.27	8.80	49.07	52.97	3.90
	S.D.	8.72	9.50		9.39	12.17		10.15	9.97	
Pinellas Mathematics	Mean	47.10	51.93	4.83	49.86	55.53	5.67	50.04	55.54	5.50
	S.D.	10.10	11.21		9.00	9.45		9.65	10.68	
Pinellas Social Studies	Mean	46.91	49.53	2.62	50.29	54.14	3.85	49.63	53.32	3.69
	S.D.	9.70	10.52		9.57	9.17		9.97	10.34	
Pinellas Science	Mean	46.28	51.43	5.15	49.13	55.39	6.26	49.71	55.19	5.48
	S.D.	9.87	10.34		9.50	9.34		9.96	9.95	

Table VIII-42. -- Mean Seventh Grade Standard Score Gains by Schools and Differences Between Mean Gains of Oak Grove and Each Other School on Each Test, Academic Year 1962-63.

	Pinellas Park (N=297)		Oak Grove (N=190)		Tyrone (N=374)
Word Knowledge	9.62		10.38		9.87
Diff. (Oak Grove-Other)		+0.76		+0.51	
Reading	5.16		5.11		4.90
Difference		-0.05		+0.21	
Spelling	5.16		7.34		4.75
Difference		+2.18		+2.59	
Language Usage	2.93		9.94		6.06
Difference		+7.03		+3.88	
Language Study Skills	2.99		4.16		3.74
Difference		+1.17		+0.42	
Arithmetic Computation	6.34		7.01		5.85
Difference		+0.37		+1.16	
Arithmetic Problems	3.96		6.35		3.75
Difference		+2.39		+2.65	
Social Studies	2.78		5.40		2.19
Difference		+2.62		+3.21	
Social Studies Skill	2.57		5.26		2.71
Difference		+2.69		+2.55	
Science	3.98		5.68		4.67
Difference		+1.70		+1.01	
Pinellas English	1.11		7.28		2.32
Difference		+6.17		+4.96	
Pinellas Mathematics	7.89		9.43		6.05
Difference		+1.54		+3.37	
Pinellas Social Study	3.55		4.72		2.77
Difference		+1.17		+1.95	
Pinellas Science	6.63		12.72		8.00
Difference		+6.09		+4.72	
Number Positive Differences		13		14	
Number Negative Differences		1		0	

Table VIII-43. -- Mean Eighth Grade Standard Score Gains by Schools and Differences Between Mean Gain of Oak Grove and Each Other School on Each Test, Academic Year 1962-63.

	Pinellas Park (N=260)		Oak Grove (N=223)		Tyrone (N=408)
Word Knowledge	10.70		11.81		12.17
Diff. (Oak Grove-Other)		+1.11		-0.31	
Reading	3.86		1.64		2.24
Difference		-2.22		-0.60	
Spelling	3.40		4.23		3.19
Difference		+0.83		+1.04	
Language Usage	2.58		8.00		5.05
Difference		+5.42		+2.95	
Language Skills	0.75		2.41		2.61
Difference		+1.66		-0.20	
Arithmetic Computation	3.80		3.44		4.15
Difference		-0.36		-0.71	
Arithmetic Problems	2.97		4.08		3.06
Difference		+1.11		+1.02	
Social Studies	3.70		4.26		3.19
Difference		+0.56		+1.07	
Social Study Skills	-0.64		2.30		1.32
Difference		+2.94		+0.98	
Science	-0.80		2.70		-0.37
Difference		+3.50		+3.07	
Pinellas English	4.15		7.92		3.62
Difference		+3.77		+4.30	
Pinellas Mathematics	6.18		5.11		6.09
Difference		-1.07		-0.98	
Pinellas Social Study	4.20		3.00		5.07
Difference		-1.20		-2.07	
Pinellas Science	1.07		2.23		1.09
Difference		+1.16		+1.14	
Number Positive Differences		10		8	
Number Negative Differences		4		6	

Table VIII-44. -- Mean Ninth Grade Standard Score Gains and Differences Between Mean Gain of Oak Grove and Each Other School on Each Test, Academic Year 1962-63.

	Pinellas Park (N=262)		Oak Grove (N=206)		Tyrone (N=396)
Word Knowledge	11.84		14.86		14.49
Diff. (Oak Grove-Other)		+3.02		+0.37	
Reading	4.95		4.54		5.89
Difference		-0.41		-1.35	
Spelling	1.86		4.61		2.33
Difference		+2.75		+2.28	
Language Usage	3.80		6.64		3.86
Difference		+2.84		+2.78	
Language Study Skills	0.97		2.86		3.77
Difference		+1.89		-0.91	
Arithmetic Computation	1.65		4.07		0.29
Difference		+2.42		+3.78	
Arithmetic Problem	1.87		3.10		1.80
Difference		+1.23		+1.30	
Social Studies	4.17		3.35		3.24
Difference		-0.82		+0.11	
Social Study Skills	3.06		3.55		3.34
Difference		+0.49		+0.21	
Science	5.13		5.79		5.13
Difference		+0.66		+0.66	
Pinellas English	2.02		8.80		3.90
Difference		+6.78		+4.90	
Pinellas Mathematics	4.83		5.67		5.50
Difference		+0.84		+0.17	
Pinellas Social Studies	2.62		3.85		3.69
Difference		+1.23		+0.16	
Pinellas Science	5.15		6.26		5.48
Difference		+1.11		+0.78	
Number Positive Differences		12		12	
Number Negative Differences		2		2	

The adequacy of the tests as measuring instruments may be considered further by examining the relationships between the mean scores for each grade and those for the immediately preceding grade. On achievement tests covering this range of grades, the following relationships should hold:

Grade 8 > Grade 7

Grade 9 > Grade 8

The data in Table VIII-45 report the frequencies with which these relationships hold for both the pre-tests and the post-tests at each of the three schools. These data indicate that on the pre-tests the eighth grade scored higher than did the seventh in 13 of the 14 tests at Pinellas Park, the deviant test being Pinellas English. At each of the other schools the eighth grade scored higher than did the seventh on all pre-tests. On the post-tests the eighth grade scored higher than did the seventh on all tests at Pinellas Park and at Tyrone and on 13 of the 14 tests at Oak Grove, the deviant test being Pinellas Science.

Table VIII-45. -- Discrimination of Grade Levels of Pre-Tests and Post-Tests in Each of the Three Schools, Academic Year 1962-63. *

	Pinellas Park				Oak Grove				Tyrone			
	Pre-test		Post-test		Pre-test		Post-test		Pre-test		Post-test	
Relationship	8>7	9>8	8>7	9>8	9>7	9>8	8>7	9>8	8>7	9>8	8>7	9>8
f	13	14	14	14	14	14	13	14	14	14	14	13
Combined %	96. 43		100		100		96. 43		100		96. 43	
Dev. Test	Pinellas English						Pinellas Science				Pinellas Math.	

*The number of students involved in each grade are reported in Table VIII-36.

The ninth grades scored higher than did the eighth on all pre-tests at all schools and also on all post-tests, with the exception of one test at Tyrone. The deviant test was Pinellas Mathematics. The percentage of discrimination of the tests is reported as the combined percentage. This row indicates that in three of the possible six categories the discrimination index of the battery was 96. 43% and in the remaining three, 100%.

The differences between pre-test and post-test results were examined to determine consistency with which the tests in the battery yielded positive gains at each grade level in each school. These data are reported in Table VIII-46. The data in this table indicate that over all grades the battery discriminated gains during the academic year on 40 of the 42 tests at Pinellas Park, on all tests at Oak Grove and on 41 of the 42 tests at Tyrone. All failures to discriminate were at the eighth grade level. The Metropolitan Science test failed to discriminate achievement gains at the eighth grade level in both Pinellas Park and Tyrone and the Metropolitan Social Studies Study Skills test so failed at the eighth grade level in Pinellas Park.

Table VIII-46. -- Number of Tests on Which Differences Between Pre-Test and Post-Test Mean Scores Were Positive and Negative, Classified by School and Grade, Academic Year 1962-63.

	Pinellas Park No. of Differences		Oak Grove No. of Differences		Tyrone No. of Differences	
	Positive	Negative	Positive	Negative	Positive	Negative
Grade 7	14	0	14	0	14	0
8	12	2	14	0	13	1
9	14	0	14	0	14	0
Total	40	2	42	0	41	1
% Disc.	95.24		100.00		97.62	

3. Summary of the Academic Years.

This study of academic achievement was conducted over a period of two academic years in the same schools. The instructional content of four areas - English, mathematics, social studies and science - was outlined in study guides for the use of the teachers of these schools. The results were determined on the basis of gains in achievement as measured by a test battery which was logically valid and which operationally met the accepted standards of measurement in this field.

The climatic condition measured in terms of student comfort was the independent variable and achievement gain was the dependent variable. Other variables were not controlled or measured. It was indicated that the schools differed in terms of the socio-economic levels of the communities which they served. Pinellas Park enrolled children from a community that was less privileged than was the Oak Grove community. The communities served by Tyrone and by Oak Grove were practically equivalent. The faculties of the several schools may have differed with respect to basic competence, but no measures of such competence were taken. The methods of employment and of assignment of teachers in this county school system are such that teacher differences by schools were probably less than exist among an unselected sample of the population of American schools. Instructional materials may be presumed to have been equally adequate in all schools. On the basis of prior performance, the achievement level of students in Oak Grove was expected to exceed that of students in Pinellas Park and to be less than that of students in Tyrone.

The analyses of student comfort on an annual and on a seasonal basis established the superiority of Oak Grove, the climate controlled school, over each of the other schools during both academic years under study. They also indicated that the superiority over Pinellas Park was greater than over Tyrone during a majority of the time the first year and during about half the time the second year. During those weeks when Pinellas Park was more comfortable than Tyrone, the differences between the two were small. During those weeks when Tyrone was more comfortable than Pinellas Park, the differences were relatively large.

Fourteen tests were administered as pre-and-post tests. The criterion measures were the differences between mean post-test and pre-test scores which represent gains in achievement as measured by each test.

The results of these analyses show that during the academic year 1961-62, the gains of Oak Grove students as a school exceeded those of Pinellas Park students as a school on 11 of the 14 tests and were less on 3 of the 14 tests. During the second year, the gains of Oak Grove students as a school exceeded those of Pinellas Park students as a school on 13 of the 14 tests and were less on 1 of the 14 tests.

The results show that during the academic year 1961-62, the gains of Oak Grove students as a school exceeded those of the Tyrone students as a school on 9 of the 14 tests and were less on the remaining 5 tests. During the second year, the gains of Oak Grove students exceeded those of Tyrone students on 13 of the 14 tests and were less on 1 test.

The consistency of the differences by grades over schools was also examined. The results are summarized in Table VIII-47. During the year 1961-62, Oak Grove's superiority of 26-16 over Pinellas Park appears to have been largely due to the performance of the seventh grade, with the eighth grade contributing only a difference of 2 tests and the ninth grade contributing none. During the second year the superiority amounting to 35-7 was attained by quite consistent superiority at each and every grade level.

battery discriminated gains during the academic year on 40 of the 42 tests at Pinellas Park, on all tests at Oak Grove and on 41 of the 42 tests at Tyrone. All failures to discriminate were at the eighth grade level. The Metropolitan Science test failed to discriminate achievement gains at the eighth grade level in both Pinellas Park and Tyrone and the Metropolitan Social Studies Study Skills test so failed at the eighth grade level in Pinellas Park.

Table VIII-46. -- Number of Tests on Which Differences Between Pre-Test and Post-Test Mean Scores Were Positive and Negative, Classified by School and Grade, Academic Year 1962-63.

	Pinellas Park No. of Differences		Oak Grove No. of Differences		Tyrone No. of Differences	
	Positive	Negative	Positive	Negative	Positive	Negative
Grade 7	14	0	14	0	14	0
8	12	2	14	0	13	1
9	14	0	14	0	14	0
Total	40	2	42	0	41	1
% Disc.	95.24		100.00		97.62	

3. Summary of the Academic Years.

This study of academic achievement was conducted over a period of two academic years in the same schools. The instructional content of four areas - English, mathematics, social studies and science - was outlined in study guides for the use of the teachers of these schools. The results were determined on the basis of gains in achievement as measured by a test battery which was logically valid and which operationally met the accepted standards of measurement in this field.

The climatic condition measured in terms of student comfort was the independent variable and achievement gain was the dependent variable. Other variables were not controlled or measured. It was indicated that the schools differed in terms of the socio-economic levels of the communities which they served. Pinellas Park enrolled children from a community that was less privileged than was the Oak Grove community. The communities served by Tyrone and by Oak Grove were practically equivalent. The faculties of the several schools may have differed with respect to basic competence, but no measures of such competence were taken. The methods of employment and of assignment of teachers in this county school system are such that teacher differences by schools were probably less than exist among an unselected sample of the population of American schools. Instructional materials may be presumed to have been equally adequate in all schools. On the basis of prior performance, the achievement level of students in Oak Grove was expected to exceed that of students in Pinellas Park and to be less than that of students in Tyrone.

The analyses of student comfort on an annual and on a seasonal basis established the superiority of Oak Grove, the climate controlled school, over each of the other schools during both academic years under study. They also indicated that the superiority over Pinellas Park was greater than over Tyrone during a majority of the time the first year and during about half the time the second year. During those weeks when Pinellas Park was more comfortable than Tyrone, the differences between the two were small. During those weeks when Tyrone was more comfortable than Pinellas Park, the differences were relatively large.

Fourteen tests were administered as pre-and-post tests. The criterion measures were the differences between mean post-test and pre-test scores which represent gains in achievement as measured by each test.

The results of these analyses show that during the academic year 1961-62, the gains of Oak Grove students as a school exceeded those of Pinellas Park students as a school on 11 of the 14 tests and were less on 3 of the 14 tests. During the second year, the gains of Oak Grove students as a school exceeded those of Pinellas Park students as a school on 13 of the 14 tests and were less on 1 of the 14 tests.

The results show that during the academic year 1961-62, the gains of Oak Grove students as a school exceeded those of the Tyrone students as a school on 9 of the 14 tests and were less on the remaining 5 tests. During the second year, the gains of Oak Grove students exceeded those of Tyrone students on 13 of the 14 tests and were less on 1 test.

The consistency of the differences by grades over schools was also examined. The results are summarized in Table VIII-47. During the year 1961-62, Oak Grove's superiority of 26-16 over Pinellas Park appears to have been largely due to the performance of the seventh grade, with the eighth grade contributing only a difference of 2 tests and the ninth grade contributing none. During the second year the superiority amounting to 35-7 was attained by quite consistent superiority at each and every grade level.

Table VIII-47. -- Summary of Frequencies of Signed Differences Between Oak Grove and Each of the Two Other Schools in Tested Achievement. 1961-1962 and 1962-1963

Grade	Oak Grove vs.							
	Pinellas Park				Tyrone			
	1961-62		1962-63		1961-62		1962-63	
	+	-	+	-	+	-	+	-
7	11	3	13	1	7	7	14	0
8	8	6	10	4	8	6	8	6
9	7	7	12	2	6	8	12	2
Totals	26	16	35	7	21	21	34	8

The results of the grade by grade analyses literally added up to no difference between Oak Grove and Tyrone for the academic year 1961-62. The differences by grades were 7 (exactly half of the tests) plus or minus one test. The differences over all grades during the second year showed Oak Grove to be superior to Tyrone on 34 of the possible 42 comparisons. The differences at each grade favored Oak Grove, but were quite variable from grade-to-grade.

In all but one of the academic year comparisons reported, the gains of students at Oak Grove, the climate controlled school, exceeded in frequency those of students at Pinellas Park and in the one exceptional comparison there was no difference.

In the case of the relationship between Oak Grove and Tyrone the differences for the academic year 1961-62 over all grades favored Oak Grove but the differences by grades were null, thus casting grave doubt on the significance of the total school results. The differences the second year favored Oak Grove as a school and were fairly well supported by consistent and similar differences by grades.

D. Summary of the Study of Achievement and Discussion of Results

This study has produced comparisons of the gains in achievement of students in Oak Grove, a climate controlled school, with the gains in achievement of students in Northeast during each of two summer terms and with students in Pinellas Park and in Tyrone during each of two academic years -- a total of six comparisons. All schools other than Oak Grove were non-climate controlled and their design and construction were typical of schools in the southeast. The analyses indicated that Oak Grove's gains were superior in four of the comparisons, were equal to those of the other school in two comparisons, and were inferior in none. The comparisons with specific schools indicated that Oak Grove's gains were superior to those of Pinellas Park in each of two academic years; were equal to Tyrone's the first year and greater than Tyrone's the second; were greater than Northeast's the first summer and equal to Northeast's the second summer. The record may be interpreted as indicating that the gain in achievement of the students in Oak Grove was superior to that of the students in the non-climate controlled schools over the period covered in this study.

The basic question will be asked: "To what extent did the control of climate contribute to the results reported?" It is impossible to give a definitive answer on the basis of this research. There very probably were factors other than the comfort of the students which affected their achievement and these factors could not be controlled in the setting of this study. However, some of the factors that are generally considered important were restricted but not completely controlled. The differences between the basic abilities of the student bodies were reduced by the process of selecting control schools. The instructional materials were probably equally appropriate and equally available to students in all schools. The general qualifications of the teaching faculties were more nearly similar than probably would have been the case had the schools not been units in the same system.

The effectiveness of the teachers as instructors may have differed. Granting that it did, the possibility should be considered that the difference was associated in part with differences in the comfort levels of these schools. Other things being equal, a climate controlled school might well attract the better teachers. Of greater importance is the possibility that comfortable classrooms contribute to the effective performance of teachers as instructors.

To the degree that some differences between schools were reduced and to the degree that other differences were correlated with climate, the uncontrolled variables were not random. This argument does not prove that the control of climate did contribute to the differences favorable to Oak Grove. The argument suggests that the conditions under which this study was conducted makes it somewhat more probable that climate control was a contributing factor than would have been the case if no restrictions had been imposed upon the uncontrolled variables.

A closely related question will be asked: "Will the results reported also hold in other schools and, in the future, in these schools?" A definitive answer to either part cannot be given on the basis of logical inference because the operating factor, or factors, may not have been identified and hence the probability of their existence in other schools, or at some future time in these schools, cannot be known. Statistical inference cannot be employed because these schools were not chosen as samples, but as cases.

It should be recognized that intuitive interpretations of this field study may be more valid than those which these investigators as professional researchers can permit themselves. It should also be recognized that from the data reported a practicing school administrator may infer more accurately the effect of climate control upon a specific school than can persons having no knowledge of the characteristics of that school. Indeed, a part of the reason for reporting in the detail given was to enable those who wish to do so to make intuitive interpretations and specific applications. These investigators are not presently in the position to make either.

E. Addendum Addressed to Future Investigators

The failure to control teacher differences will undoubtedly be considered a weakness of this study. The investigators suggest if these differences are defined in terms of basic competence, there are no measures of such. If teacher differences are defined in terms of effective performance, it is possible that such differences are positively related to teacher comfort. If so, differences in the effectiveness of teacher performance should not be nullified, but hypothesized to be an intervening variable correlated with climate.

The relationship between learning and the levels of comfort attainable with, and without, climate control is a fundamental problem which merits careful study. Investigators who attempt such study would do well to define the kind of learning they propose to study. It seems possible that motor learning as measured by performance tests of speed and accuracy will prove to be adversely affected under less extreme conditions of discomfort than will cognitive learning. The reason for this statement is the fact that the available knowledge indicates that the expenditure of energy is greater for learning involving physical performance than for cognitive learning. The investigators also suggest that the tempo, or pace, of learning may be an important factor. It is possible that an increase in fatigue, but not an actual decrement in learning, may occur, if the pace does not push the energy expenditure near the limit of that available under the given climatic conditions. The investigators further suggest that the duration of a given condition may exert cumulative effects upon learning that are reduced, or lost, if climatic conditions are permitted to fluctuate within the day or from day-to-day.

CHAPTER IX

DISCIPLINE

The relationship between the climatic conditions of the schools and the conduct of students was an area identified for study. It was hypothesized that students would modify their conduct as climatic conditions changed. It was also conceivable that teachers would become more critical of student behavior as climatic conditions became uncomfortable. By hypothesis, the net effect would be an increase in the number of occurrences of infractions of school discipline with the decrease in the comfort of students and teachers.

A. Infractions of School Discipline

"Infraction" is a generic term whose precise meaning varies from teacher to teacher, from school to school, and from time to time. Infractions also vary in seriousness, ranging from the minor infractions which are corrected by a word, a look, or a motion by the teacher to those having such serious social and educational consequences that they are referred to the central administration of the school. In general school operation, minor infractions are numerically much greater than are the more serious ones. The difficulty of obtaining a reliable count and of establishing valid definitions that would hold over all schools and all teachers and throughout the course of this study was such that the investigators did not attempt to collect data on minor infractions. The infractions considered were those, and only those, which were referred to the respective school's disciplinary officer or officers, whether these officers held the title of assistant principal or dean of boys or of girls.

This operating definition reduced the variability in the data which would have been associated with teacher differences and with transient situations within the classroom, but probably did not eliminate such. The definition also reduced the sensitivity of the data to the hypothesized changes in student behavior associated with variable climatic conditions because it eliminated records of minor restlessness, ennui, and misconduct which probably would be the most frequent student reactions.

B. Plan for Discipline Study

The investigators developed the plan for the study of student infractions in conference with the local school administrators. There was general agreement that infractions could be classified under sixteen headings, each of which was generally understood and sufficiently discrete to give it distinct meaning. To these sixteen, a seventeenth heading, "Others," was added for the purpose of subsuming those assorted deviant behaviors which occurred very infrequently and those infractions which could not be clearly classified by the school's disciplinary officer. The classifications appear as row headings in Figure IX-1.

When the data were recorded, the school day was divided into three periods, "before lunch," "lunch," and "after lunch." With the exception of the time spent between home and school and the few minutes on the school grounds before and after the opening of instruction, the periods before and after lunch were spent under teacher supervision in classrooms. The lunch period was spent by most students in the cafeteria and in relaxation or informal recreation and was not under close surveillance by teachers. It was felt that the lunch period should not be included in either the morning or the afternoon period because its inclusion would contaminate the data for either period.

It was hypothesized that the infractions would vary systematically by grade. In schools enrolling three grades, namely 7, 8, and 9, it seemed plausible that the older students in the ninth grade systematically would behave differently from the younger students in the seventh grade both because of age and of status with the school. The eighth grade, being the middle grade, might itself behave differently from either of the other two.

It was hypothesized that students' behavior would systematically vary by sex, both in terms of the number of infractions per student and in terms of the kinds of infractions. It was also hypothesized that there would be systematic variation by school and by day of week. It was also hypothesized that behavior during periods near the beginning and close of school and preceding and following holidays would differ from that during the remainder of the school year. The date was also necessary for relating the record of infractions to the climatic conditions existing at the time. The "Discipline Record" reproduced as Figure IX-1, was the data-gathering device utilized for this section of the study.

C. Data Gathering

The person in charge of discipline was responsible for the daily tabulations of disciplinary infractions in each school. The sums of rows and of columns were entered daily at each school and checked by a research project staff member. The primary enumeration and classification of infractions was the responsibility of the person in charge of discipline in each school and was not altered by other persons involved in the project.

Complete reports were received for all three schools for each of

School DISCIPLINE RECORD Date Day

Infractions	Before Lunch						During Lunch						After Lunch						Total
	Grade 7		Grade 8		Grade 9		Grade 7		Grade 8		Grade 9		Grade 7		Grade 8		Grade 9		
	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	
Abuse of privileges																			
AWOL																			
Bus conduct																			
Cheating																			
Destruction of school property																			
Disregard for students																			
Fighting																			
Horseplay, running																			
Insubordination																			
Irregular Attendance																			
Smoking																			
Stealing																			
Tardiness - chronic																			
Throwing objects																			
Trouble in cafeteria																			
Using profanity																			
Others -																			
TOTAL																			

Figure IX-1. Discipline Record Used for Reporting Infractions of School Discipline.

177 of the days school was in session. On the remaining days one or another of the schools was unable to submit a report. These days occurred during the first week of school, so the effect was to begin this phase of the study with the second week (the first full week) of school. It is the opinion of the investigators that the reports of infractions are substantially accurate, that any inaccuracies are in the form of omissions, and that such omissions occurred more probably on days of heavy infractions than on days having the normal and less than the normal number of infractions.

D. Discipline Infractions Data

The basic pattern of infractions is presented in Table IX-1. The number of infractions is presented by grade, by sex of the offender, and by totals for each school. The number of students enrolled at the close of the first month was used as the basis for computing the infraction rate. This rate was expressed as the number of infractions per 100 students. Enrollment at the close of the first month approximated the mean daily number of students in membership. There were small fluctuations within each school, but these tended to vary simultaneously among schools because they were due largely to winter visitors. Furthermore, the records of students in membership did not permit the divisions by sex and by grade. Average daily attendance was not an appropriate statistic because non-attendance under certain conditions was reported as an infraction. The use of the number of students enrolled at the end of the first month as the base for computing rates of infraction, therefore, seemed more appropriate than the use of other possible statistics. The rates thus obtained are very slightly greater than would have been obtained had the number in daily membership been used.

Variability of numbers and rates of infractions among the schools, among the grades within schools, and between the sexes by schools and within schools is the most striking impression conveyed by this table. The load of disciplinary cases was 686 at Oak Grove, 1342 at Tyrone and 2911 at Pinellas Park. The rates per hundred students were 94.4, 95.0 and 263.0, respectively.

The number of infractions per grade was influenced by the enrollment in the grade but this was not consistent over grades or over schools. The rates for each grade were higher at Pinellas Park than at either of the other schools. The rates in the seventh and in the eighth grades at Oak Grove were higher than in these respective grades at Tyrone, but the opposite was true in the ninth grade at these schools. The sex differences among schools is perhaps the most striking feature of this table. The rate for girls at Oak Grove was 13.6 per hundred while that at Tyrone and at Pinellas Park was 65.2 and 189.3, respectively. It is an axiom in American education that boys are more prone to infractions

Table IX-1. -- Infraction of School Discipline Classified by School, Grade and by Sex, 1961-62.

	Grade 7			Grade 8			Grade 9			Total students		
	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total
OAK GROVE												
No. Infr.	240	22	262	242	20	262	159	3	162	641	45	686
Enroll.	152	132	284	147	108	255	120	117	237	395	332	727
Inf/100Enr.	157. 9	16. 7	92. 3	164. 6	18. 5	102. 7	132. 5	2. 6	68. 4	162. 3	13. 6	94. 4
PINELLAS PARK												
No. Infr.	858	243	1101	753	380	1133	310	367	677	1921	990	2911
Enroll.	221	205	426	222	196	418	174	153	327	580	523	1103
Inf/100Enr.	388. 2	118. 5	258. 5	339. 2	193. 9	271. 1	178. 2	239. 9	207. 0	331. 2	189. 3	263. 0
TYRONE												
No. Infr.	255	88	343	266	200	466	346	187	533	867	475	1342
Enroll.	288	246	474	245	247	492	262	272	534	701	729	1413
Inf/100Enr.	88. 5	35. 7	72. 3	108. 6	81. 0	94. 7	132. 1	68. 8	99. 8	123. 7	65. 2	95. 0

than are girls, but a situation in which the ratio of infractions rates of boys to girls are of the order of 1. 9, 1. 7, and 11. 9 suggests that the standards applied to the two sexes are radically different in the third school from those applied in the first two. However this may be, a total of 45 infractions by girls at Oak Grove over a period of 177 school days is not sufficiently large to apportion by time and condition in the treatment of these data. This fact caused the investigators to limit the analyses to boys in the three schools.

1. Frequency of Daily Infractions

The central interest in this inquiry is not the number of infractions, per se, but the distribution by days of whatever number of infractions may have occurred and the relationship between daily climatic conditions and the number of daily infractions. The distribution of daily infractions per hundred enrolled boys in each school is depicted in Figure IX-2. The frequency curves for Oak Grove, the climate controlled school, and for Tyrone, one of the non-climate controlled schools, are quite similar in form. The curve for Pinellas Park, the second non-climate controlled school, differs in form from that of both the climate controlled school and the other non-climate controlled school.

The most frequently occurring rate of daily infractions in Oak Grove and in Tyrone was zero. Both schools displayed a rather systematic decrease in the frequency as the rate of infractions increased, thus producing curves that were skewed to the right. During one half of the days studied, the infraction rates in Tyrone and in Oak Grove were equal to or less than . 71 and . 76 per hundred enrolled boys, respectively. Pinellas Park experienced a distribution that suggests the normal probability curve, with low daily rates of infractions occurring relatively infrequently, an increase occurring as the mean is approached and then a rather systematic decrease in frequency with increasingly high rates of infractions. If climatic conditions were a principal contributing factor to pupil behavior of the type considered in this study, Oak Grove, the climate controlled school, could be expected to display a curve that was distinct from those displayed by each of the two non-climate controlled schools and the two non-climate controlled schools should be more similar in general form. Therefore, the data displayed in Figure IX-2 tend to cast doubt upon the functional relationship between climate and the tendency of boys to commit infractions of school discipline.

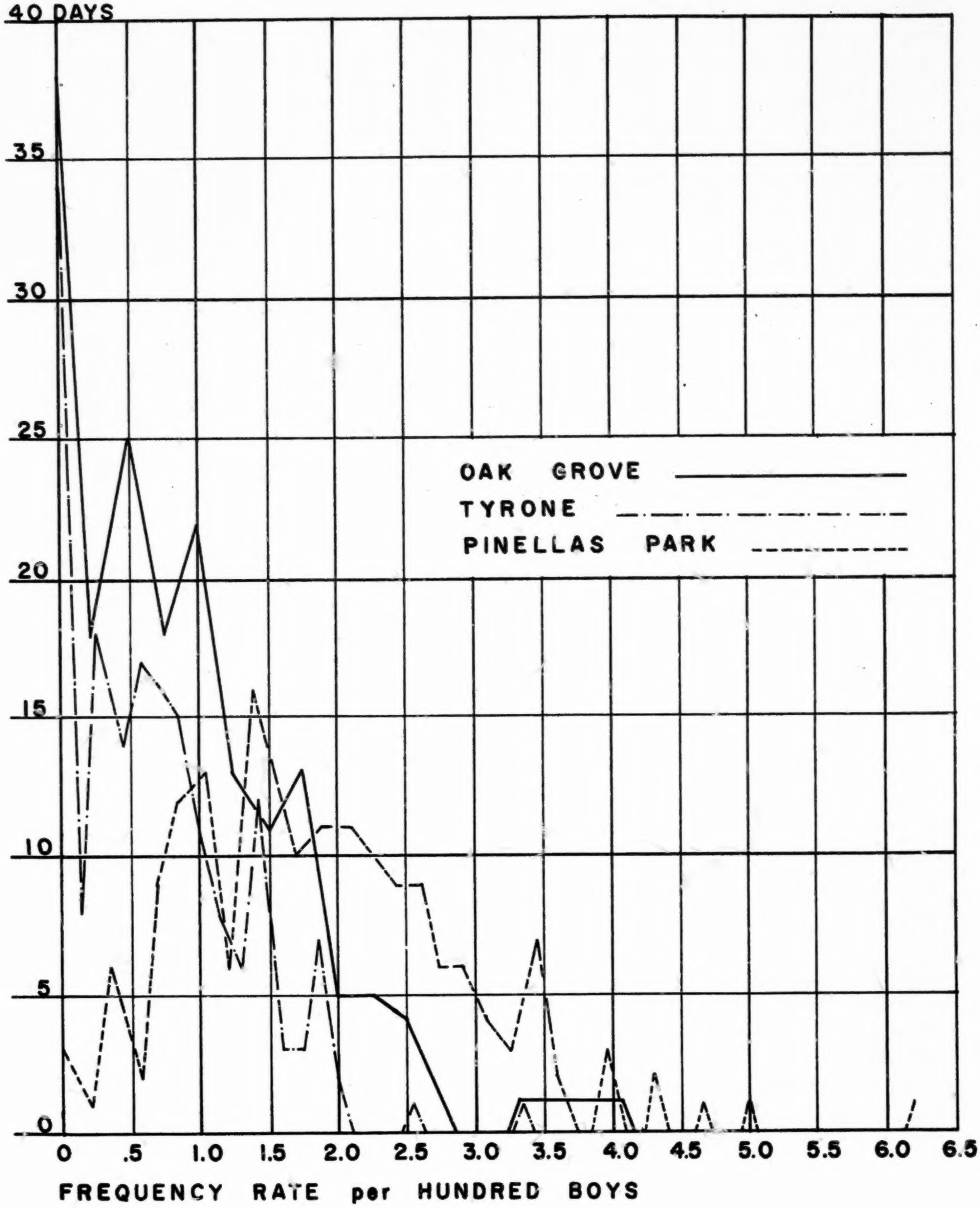


Figure IX-2. -- Frequency Distribution of Daily Infractions 1961-62

2. Discipline Infractions and Comfort Indices

The second analysis to which these data were subjected involved the testing of the relationship between the mean of the daily infractions per week and the mean of the daily comfort indices for each respective week. The justification for the adoption of the school week as the basic unit for this inquiry rests upon the fact that the daily variability in the number of infractions was patently unrelated to the daily variability of temperature; i. e., the juxaposition of "good days" and "bad days" rarely, if ever, coincided with the juxaposition of "cool days" and "hot days". This fact may have been due to the mis-dating of certain types of infractions, for instance, absence without leave or bus conduct on the way home. The student in such cases committed the offense one day but it could not be adjudicated until the student returned to school. Over a week's time, in general practice, most infractions were recorded, so a week's report is probably more accurate than any given day's report. Climatic conditions tend to change gradually rather than to fluctuate greatly from day-to-day. In common parlance, teachers speak of comfortable or uncomfortable days but tend to imply that a week of comfortable or uncomfortable weather is a more serious matter. It therefore seemed advisable to adopt the school week as the unit of time in this portion of the analysis and to compute the daily means within each week. The mean daily disciplinary infractions and the mean daily comfort indices are reported by week in Table IX-2. The reader will note that these data report the mean number of infractions per day by week, and not infraction rates per hundred boys. Therefore, the entries are not directly comparable to the rates per 100 enrolled boys which have been considered previously.

The forms of the three distributions suggested that measures that were free of such rigorous assumptions as normality should be used in testing the relationship between the number of infractions and comfort levels. The Chi Square technique was selected. This technique requires that the distributions be partitioned and that the data be categorized within units of the partitioning scheme devised.

The distribution of infractions was partitioned by stanines, thus yielding nine categories for each school. Since each stanine is a function of the standard deviation of the distribution from which it was derived and since the stanine distribution is symmetrical about the mean of its respective raw score distribution, the use of stanines as designators of weeks preserves the position of each week relative to the others in its distribution of infractions.

Table IX-2. -- Mean Daily Infractions by Week and Stanine Level of Each; Weekly Comfort Indices and Dichotomous Classifications of Each. Oak Grove, Tyrone and Pinellas Park for 1961-62.

Week beginning	School and Annual Comfort Index											
	Oak Grove (C=.858)				Tyrone (C=.649)				Pinellas Park (C=.547)			
	Infractions		Wk. Comfort		Infractions		Wk. Comfort		Infractions		Wk. Comfort	
	N	Stan. level	Index	Sign level	N	Stan. level	Index	Sign level	N	Stan. level	Index	Sign level
9-11	0.4	I	.83	-	0.8	I	.52	-	4.2	I	.33	-
18	2.2	II	.83	-	6.0	III	.63	-	6.4	I	.40	-
25	2.8	II	.90	+	6.0	III	.52	-	7.0	I	.28	-
10-02	2.8	II	.89	+	7.0	III	.71	+	7.8	I	.47	-
09	4.8	II	.87	+	2.4	II	.60	-	8.8	II	.43	-
16	2.0	I	.90	+	3.2	II	.67	+	9.6	II	.62	+
23	2.6	II	.89	+	3.5	II	.71	+	6.4	I	.52	-
30	2.8	II	.90	+	8.8	III	.57	-	15.8	III	.47	-
11-06	2.6	II	.84	-	7.0	III	.63	-	13.4	II	.52	-
13	2.0	I	.84	-	5.2	II	.63	-	10.4	II	.52	-
20	6.0	III	.84	-	5.0	II	.71	+	7.7	I	.72	+
27	2.0	I	.84	-	4.8	II	.69	+	9.0	II	.57	+
12-04	2.0	I	.88	+	5.8	III	.71	+	9.2	II	.57	+
11	5.4	III	.90	+	5.4	II	.71	+	15.4	III	.47	-
1-02	0.8	I	.83	-	3.0	II	.69	+	4.3	I	.47	-
08	3.8	II	.90	+	3.8	II	.65	+	9.4	II	.67	+
15	2.2	II	.87	+	9.6	III	.68	+	7.0	I	.72	+
22	1.8	I	.84	-	8.0	III	.71	+	5.6	I	.67	+
30	2.0	I	.84	-	3.8	II	.62	-	10.0	II	.72	+
2-05	3.6	II	.88	+	5.2	II	.65	+	13.0	II	.72	+
12	4.2	II	.83	-	8.4	III	.65	+	14.4	III	.72	+
19	6.0	III	.86	+	1.6	I	.67	+	13.4	II	.47	-
26	4.8	II	.90	+	2.8	II	.63	-	17.6	III	.47	-
3-05	3.2	II	.78	-	3.6	II	.71	+	11.6	II	.72	+
12	2.2	II	.83	-	6.0	III	.71	+	10.4	II	.72	+
19	6.0	III	.86	+	3.8	II	.71	+	15.5	III	.72	+
26	7.2	III	.83	-	2.8	II	.71	+	11.4	II	.67	+
4-02	7.4	III	.83	-	3.6	II	.71	+	17.6	III	.72	+
09	6.0	III	.83	-	4.8	II	.57	-	15.6	III	.47	-
16	3.3	II	.83	-	7.5	III	.63	-	14.3	III	.72	+
24	1.3	I	.85	-	5.7	III	.66	+	11.0	II	.47	-
30	3.8	II	.83	-	3.8	II	.52	-	13.4	II	.47	-
5-07	4.6	II	.86	+	5.2	II	.60	-	14.4	III	.47	-
14	6.0	III	.88	+	5.0	II	.52	-	11.2	II	.36	-
21	3.0	II	.90	+	4.2	II	.52	-	11.6	II	.29	-
28	5.8	III	.85	-	11.8	III	.52	-	19.5	III	.26	-
6-04	1.4	I	.90	+	4.8	II	.52	-	7.8	I	.25	-

For each school, the distribution of comfort indices was partitioned into two levels, above and below the annual mean of the school. The stanine distribution was compressed into three levels by consolidating stanines 1, 2, and 3 into level I, stanines 4, 5, and 6 into level II and stanines 7, 8, and 9 into level III. This grouping of data was effected because the Chi Square test requires a minimum number of frequencies, approximately five, in each cell. The 37 pairs of data reported in Table IX-2 obviously could not satisfy this requirement if distributed in a 9 x 2 table.

The resulting distributions of infractions by comfort levels are shown in Table IX-3 for the Oak Grove school. The solution of this matrix yielded a $X^2 = 2.58$. With two degrees of freedom, the probability of this distribution happening by change is $p > .20$.

Table IX-3. -- Distribution of Infractions by Comfort Levels Oak Grove, 1961-62

Infraction Levels	Comfort Levels +	 -
I	3	7
II	11	7
III	4	5

The data for Tyrone were similarly treated and the distributions are reported in Table IX-4. In this form the problem cannot be solved because of the small entries in the cells at infraction level I. The data were further consolidated by combining levels I and II. The solution produced $X^2 = .057$. With one degree of freedom, the probability of this distribution occurring by chance is $p > .80$

Table IX-4. -- Distribution of Infractions by Comfort Levels Tyrone, 1961-62

Infraction Levels	Comfort Levels +	 -
I	1	1
II	12	10
III	7	6

The data for Pinellas Park were treated in the same manner as the two other schools. The distributions for this school are reported in Table IX-5. The solution of this matrix yielded $X^2 = 1.40$. With two degrees of freedom, the probability of this distribution happening by chance is $p = .50$.

This approach to the relationship between the incidence of disciplinary infractions and climate, expressed in terms of broad comfort levels, does not support the hypothesis of a functional relationship between the two at a confidence level as high as .05 for any of the schools. The null hypothesis was, therefore, not rejected.

Table IX-5. -- Distribution of Infractions by Comfort Levels Pinellas Park, 1961-62

Infraction Levels	Comfort Levels +	-
I	3	7
II	9	8
III	4	6

3. Discipline Infractions Related to Time of Day

The tendency for disciplinary infractions to differ in frequency between morning and afternoon was also a point of interest. It was hypothesized that during periods of hot weather students and their teachers might be so affected that afternoon infractions would be relatively greater than would be the case during periods of comfortable climatic conditions.

An examination of morning and afternoon temperatures at Oak Grove indicated that this hypothesis could not be tested in that school because there were no prolonged periods during which temperatures were hot enough to generate the effects under study. The investigators' knowledge of the operation of the disciplinary offices at Pinellas Park caused them to doubt that the records were sufficiently specific to permit accurate discrimination by time of the infraction. This statement is not a reflection upon the personnel of the school, but a recognition that their disciplinary load was frequently so heavy that they could not maintain accuracy in all details of the reporting process. Tyrone did furnish the necessary conditions for testing the hypothesis because it did experience wide variations in temperature and its records were sufficiently accurate with respect to the time of the infraction to justify the analysis involved.

At Tyrone, infractions were reported on 137 school days. To test the hypothesis that the number of afternoon infractions tended to exceed the number of morning infractions during periods of hot weather, the Chi Square test was used. The rows of the matrix contained the frequencies with which the number of morning infractions were equal to, or greater than, those occurring in the afternoon and the frequencies with which the number of afternoon infractions exceeded those of the morning. The columns reported the frequency of days having comfort indices of .61 or greater and the frequency of days having comfort indices of .52 or less. The data are as follows:

	$c \geq .61$	$c \geq .52$
A.M. $\geq$ P.M.	33	18
P.M. $>$ A.M.	63	23

The resulting $X^2 = 1.11$ yields a $p > .20$, which does not support the rejection at the .05 confidence level of the null form of the operating hypothesis. It then cannot be asserted at the .05 confidence level that differences between the number of morning and afternoon infractions were associated with comfort, which, in turn, was a function of temperature.

4. Discipline Infractions Related to Comfort Zones

The analyses presented thus far have afforded no substantial support for the hypothesis that the number of disciplinary infractions is related to climatic conditions expressed in terms of student comfort in any of these schools. If such relationship exists, it most probably could be detected between Comfort Zone II, having a comfort index of .72, and Comfort Zones IV and V, having comfort indices of .29 and .16 respectively, in the Pinellas Park school. These are the most extreme of the comfort conditions in any of the schools. To test this relationship, the number of daily infractions was tabulated for each of the days falling in the above zones. Disciplinary data were reported on a total of 71 days falling in Zone II and on a total of 27 days falling in Zones IV and V, combined. These data were divided into two groups, the first being the 71 days having the fewest infractions and the second, the 27 days having the most infractions. The data were then cast into a 2 x 2 contingency table, reported as Table IX-6. The solution of this table yielded $X^2 = .08$. With one degree of freedom, the probability of the division occurring by chance was $p > .70$. At the .05 confidence level, there is no support for the hypothesis that the number of disciplinary infractions was related to the climate expressed as comfort levels at the Pinellas Park school.

Table IX-6. -- Distribution of Two Levels of Infractions by Two Levels of Comfort Pinellas Park, 1961-62

Comfort Levels	Group Infraction Fewest	 Most
.72	52	19
.29 & .16	19	8

5. Types of Discipline Infractions

The investigators considered the possibility that certain types of infractions might be functionally related to climatic conditions while others were not. They grouped the seventeen listed infractions into five types as follows:

Type I:	Abuse of privileges, bus conduct, destruction of school property, disregard for student, fighting, insubordination, throwing objects, and trouble in cafeteria
Type II:	AWOL, irregular attendance and chronic tardiness
Type III:	Smoking, profanity
Type IV:	Cheating and stealing
Type V:	Other infractions

Type I behaviors are those in which the offender displays aggressiveness against persons and things. Type II are behaviors involving withdrawal from school. Type III behaviors are those often associated with gang activity in many schools or are activities through which the student typically seeks status within an "out group." Type IV behaviors are generally considered dishonest because they deprive others of their just grade or their property. Type V consisted of the miscellaneous infractions.

The studies of types of infractions were restricted to Pinellas Park because of the wider climatic differences in this school and because the number of infractions was large enough to permit partitioning by type and by climatic condition.

The climatic conditions were dichotomized for all of these analyses. Zone II, having a comfort index of .72, constituted one category and Zones III, IV and V, having comfort indices of .47, .29 and .16 respectively, were combined to make up the second category. Zone I was not utilized because no full day experienced temperature and humidity conditions defined by that zone.

The Type I infractions made up a numerically large portion of the offenses. The investigators tested the essentially null hypothesis that the offenses were distributed as the days of the school year were distributed between the two classifications of climate. The data on which the test of this hypothesis is based are reported in Table IX-7. The solution yielded $X^2 = 2.174$. With one degree of freedom, $p > .10$. The null hypothesis cannot be rejected at the .05 confidence level.

Each of the other types of infractions involved much smaller numbers. To deal with these, the researchers cumulated the infractions on a weekly basis and computed the mean of the weekly infractions. The weeks were dichotomized. Those whose infractions exceeded the mean of the weeks experiencing such infractions were classified as High and those whose infractions were less than the mean of the weeks were classified Low. The same division of climatic zones was used as for Type I, and a 2 x 2 table was set up for each of the remaining types of infractions.

The data for Type II infractions are reported in Table IX-8. The solution of these data yielded $X^2 = 4.54$. With one degree of freedom, $p < .05$. This analysis indicates that there was a direct relationship between the incidence of infractions of attendance and discomfort in the school. There are two observations that should be made. Periods of discomfort tended to occur in the fall and in the spring. The boys who were the subjects of this study may have been more greatly attracted by events outside of school during these seasons than they were repelled by the discomforts within the school. Furthermore, this is the only significant relationship of the many tested in the process of analyzing these data. By chance this analysis, among the many, might have shown significance. For these reasons the investigators retain reservations about the apparent relationship between infractions of attendance by the boys and the climate, expressed in terms of the comfort, within the Pinellas Park school.

Table IX-7. -- Distribution of Type I Infractions and School Days by Two Levels of Comfort
Pinellas Park, 1961-62

	ZONES II	ZONES III, IV, and V
Infractions	622	701
Days	76	101

Table IX-8. -- Distribution of Weekly Mean Infractions of Type II and Levels of Comfort
Pinellas Park, 1961-62

Infraction Rates	ZONES II	ZONES III, IV, and V
High	3	11
Low	14	8

The Type III infractions, smoking and profanity, proved to be unrelated to comfort conditions. The data displayed an equal distribution of cases in each of the four cells, which is pure chance. The Type IV infractions, cheating and stealing, yielded $X^2 = .07$ and $p > .70$. Type V, the miscellaneous unclassified infractions, yielded $X^2 = 1.00$ and $p > .30$.

E. Summary and Discussion

The study of the relationships between the occurrence of disciplinary infractions and the climatic conditions within the schools yielded little in the way of positive findings. The only statistically significant result was the obtained relationship between infractions of school attendance regulations and climatic conditions. The investigators suspect that these increased infractions on hot days were probably due more directly to outside attractions than to inside discomfort.

As the study progressed, the investigators became persuaded that the types of student behavior that might be related to climatic conditions were not the misconduct actions for which students were sent to the office. If students do respond to climatic conditions, their responses are probably minor types of misconduct which are corrected by teachers within the routine operation of the classroom. Such infractions necessarily must be observed and reported within the classrooms. The observational and reporting techniques employed in this study were not designed to collect disciplinary data covering infractions routinely corrected by teachers.

Because the analysis of the data for the academic year proved unproductive and because of the conviction on the part of the investigators that the techniques of data collection were inappropriate for the phenomena under study, the data for the second year were not exhaustively analyzed and are not reported.

CHAPTER X

HEALTH AND ABSENTEEISM

The health of the students in the climate controlled and in the non-climate controlled schools was a subject of interest to a number of groups. It was a subject about which there were many theories, some of which were in direct conflict. It was also a subject on which there was a paucity of data upon which to substantiate any theory. Health of the students attending these schools was therefore made a part of the total study.

A point of basic interest was the comparison of the general incidence of illnesses among students in school buildings in which blended air was continuously circulated with the incidence of illnesses of students in buildings whose ventilation depended upon the natural flow of air through open windows. Because of the difference in outcomes hypothesized by various people, the school authorities wished to know the general facts.

In the process of designing the study of health, the investigators consulted at length with professional members of the Pinellas County Department of Health; the Florida State Department of Public Health; the Savannah, Georgia, Communicable Diseases Division of the U. S. Public Health Service; local physicians and members of the Florida State University Department of Health Education and members of the School of Nursing. These consultations supplied important insights and interesting points of view. It was pointed out that because of the mild climate and the relatively low count of airborne particles in general, and of dust and certain pollens in particular, a number of families moved to the area each year seeking relief for their children from certain respiratory and allergic conditions. Basic data were needed on the extent of these types of illnesses in typical schools and their comparative incidence in climate controlled and in non-climate controlled schools in the area.

The absolute effects of the circulation of blended air were thought by many consultants not to be essentially different from that of circulation resulting from dependence upon open windows and the vagaries of the winds and weather. However, there was a genuine possibility that the patterns of the spread of airborne contagions might differ. Some consultants hypothesized that airborne contagions would spread more rapidly, peak more sharply, and pass more quickly in climate controlled than in non-climate controlled schools.

The long expanses of open and partially covered walkways were noted between classroom sections of one of the schools. Some consultants were concerned with the effects upon health of those students traversing these distances through rain and inclement weather.

The technical problems involved in making an assessment of student health were explored at length. The accurate diagnosis of many of the anticipated illnesses would require the services of physicians, laboratory technicians, and laboratory facilities which could not be made available to this project. Periodic and thorough physical examinations would be necessary if certain types of data were to be collected. Such examinations were not possible within the scope of this study. The professional role of school nurses and the extent to which they properly could go in classifying illnesses were thoroughly explored. Another topic considered was the establishment of ethical relationships between the personnel involved in this study and the members of the medical profession in private practice. Terminology presented problems. It was recognized that there were terms prevalent in lay usage which have no clinically recognized meaning and that there are terms having precise meaning to the clinician but little or no meaning to the layman.

After a great deal of deliberation, it was decided that the purposes of this project would be served by developing a plan by which the absences caused by all illnesses, and by a few major categories of illness, could be related to the total absences and to certain non-health related absences. It was further decided that the classifications of illnesses should be expressed in broad terms and in the layman's vocabulary and the classifications should be limited to those which the practicing nurse could make without compromising the ethics of her relationship with the medical profession. It was recognized that these policy decisions would limit the usefulness of the data to certain interested groups but these decisions would permit the execution of a study whose results would be valuable to the members of the educational profession and of some value to those interested in the field of public health. Further refinements or extensions would have required resources which were not at the disposal of these investigators.

A. Methods of Data Collection

The responsibility for the collection of all health data was assumed by registered public health nurses assigned to the schools for that purpose. The nurses were members of the staff of the Pinellas County Department of Health and had the support and assistance of that agency. One nurse was assigned to each school. During the study conferences were arranged on an informal basis at which the nurses discussed any problems that arose and exchanged information of a mutually helpful nature. Clerical assistance was also provided each nurse. In all cases the nurse was responsible for the accuracy and validity of the health data for the school to which she was assigned.

In consultation with nurses and physicians of the Pinellas County Health Department, detailed plans were developed. These included the use of a form entitled "Weekly Report of Absences" which carried designations that had been agreed upon for the classifications of illnesses and other causes of school absences. This form, shown as Figure X-1, listed nine

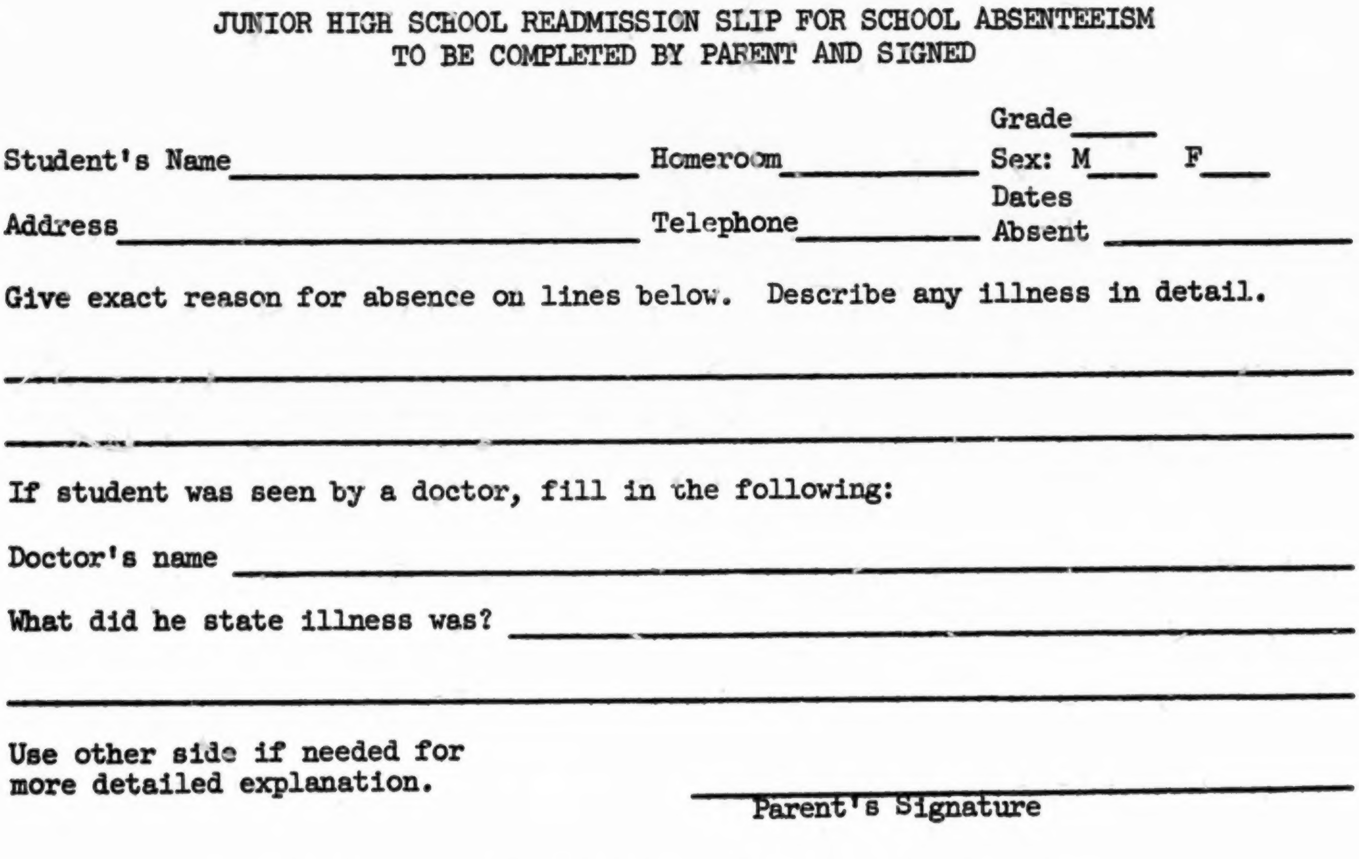
School____________________ WEEKLY REPORT OF ABSENCES Week ______________19___

Types of Absences	Confirm-ed by Doctor		Total	Grade and Sex									Days Absent									
				7			8			9			Total	7			8			9		
	Yes	No		M	F	Total	M	F	Total	M	F	Total		M	F	Total	M	F	Total	M	F	Total
A. UPPER RESPIRATORY 1. Common Cold																						
2. Hay fever																						
3. Tonsillitis																						
4. Acute bronchitis																						
5. Chronic bronchitis																						
6. Pneumonia																						
7. Influenza																						
8. Asthma (ac. or chr.)																						
9. Other																						
B. COMMUNICABLE DISEASES 10. Chicken Pox																						
11. Mumps																						
12. Measles																						
13. Other																						
C. SKIN DISEASE 14. Allergic																						
15. Infectious																						
16. Parasitic																						
17. Other																						
D. 18. HEART TROUBLE																						
E. GASTRO-INTESTINAL 19. Stomach upset																						
20. Gastro-enteritis																						
21. Other																						
F. SURGICAL 22. Minor operation																						
23. Major operation																						
24. Other																						
G. 25. MENSTRUAL																						
H. NON-SPECIFIC 26. Headache																						
27. Fatigue																						
28. Other																						
I. DENTAL 29. Toothache																						
30. Appointment																						
31. Other																						
J. ACCIDENT 32. School																						
33. Home																						
34. Traffic																						
35. Other																						
K. 36. EMOTIONAL																						
L. 37. FAMILY NEEDS																						
M. 38. PARENT-APPROVED TRIPS																						
N. RELIGIOUS OBSERVANCES 39. School approved																						
40. School unapproved																						
O. 41. TRUANCY																						
P. 42. OFFICIAL SUSPENSION																						
Q. 43. COURT OR JAIL																						
R. 44. OTHERS																						
TOTAL																						

Figure X-1. -- Form for Weekly Report of Absences.

classifications of illnesses: A. Upper Respiratory; B. Communicable Disease; C. Skin Disease; D. Heart Trouble; E. Gastro-Intestinal; F. Surgical; G. Menstrual; H. Non-Specific; and I. Dental. The remaining nine classifications of absences were not related to physical health as the term is used in this study. Under each of seven of the nine major classifications of illness, the most commonly occurring ailments were listed in lay terms. Under each of these major classifications, a category designated "Other" was included. By common agreement this was used by the nurse when she was not reasonably sure that a listed illness applied, or when she was reasonably sure that the student's illness was not one of those listed.

The plans also included the use of a readmission slip, reproduced as Figure X-2, upon which the parent supplied information about the cause of his child's absence. If the cause was illness, the parent was asked to describe the illness. If a physician attended the case, the parent was asked to report the physician's name and his diagnosis.



JUNIOR HIGH SCHOOL READMISSION SLIP FOR SCHOOL ABSENTEEISM
TO BE COMPLETED BY PARENT AND SIGNED

Student's Name ____________ Homeroom ____________ Grade ____ Sex: M ____ F ____

Address ____________ Telephone ____________ Dates Absent ____________

Give exact reason for absence on lines below. Describe any illness in detail.

If student was seen by a doctor, fill in the following:

Doctor's name ____________

What did he state illness was? ____________

Use other side if needed for
more detailed explanation.

Parent's Signature

Figure X-2. -- Readmission Slip for Absenteeism

A form, Figure X-3, was developed for recording information about those students who reported to the school clinics. The clinics were under the attention of nurses only part of each day and were supervised by non-professional aides during the remainder of the time. The reasons for coming to the clinic as listed on this form were only those which could be determined accurately by the non-professional staff. If the case was disposed of by taking the student home or to a physician, or if he was absent on the following day, the information on the clinic record and on the readmission slip was supplementary and useful to the nurse in classifying the illness.

CLINIC - PERMANENT RECORD SHEET JUNIOR HIGH SCHOOL SCHOOL YEAR 19__ - __

Date	Pupil	Grade	HR	Teacher	Reason (Code)	Disposition (Code)	Name of person making record	SAR Form *	Time In	Time Out

Check this column (*) when standard accident report form has been completed and filed with secretary.

Figure X-3. -- Continuous Record of All Students Using Clinic.

An individual record form, Figure X-4, was provided for each student visiting the clinic. Information from the running log was transferred to this form for ready reference for conferences with individual students.

JUNIOR HIGH SCHOOL CLINIC RECORD

NAME____________________ GRADE_______ HOMEROOM TEACHER__________________

DATE	TEACHER	REASON	DISPOSITION	WORKER	SAR FORM	TIME IN	TIME OUT

CODE ON BACK OF CARD

Figure X-4. -- Individual Student Clinic Record.
(Front and back)

CODE

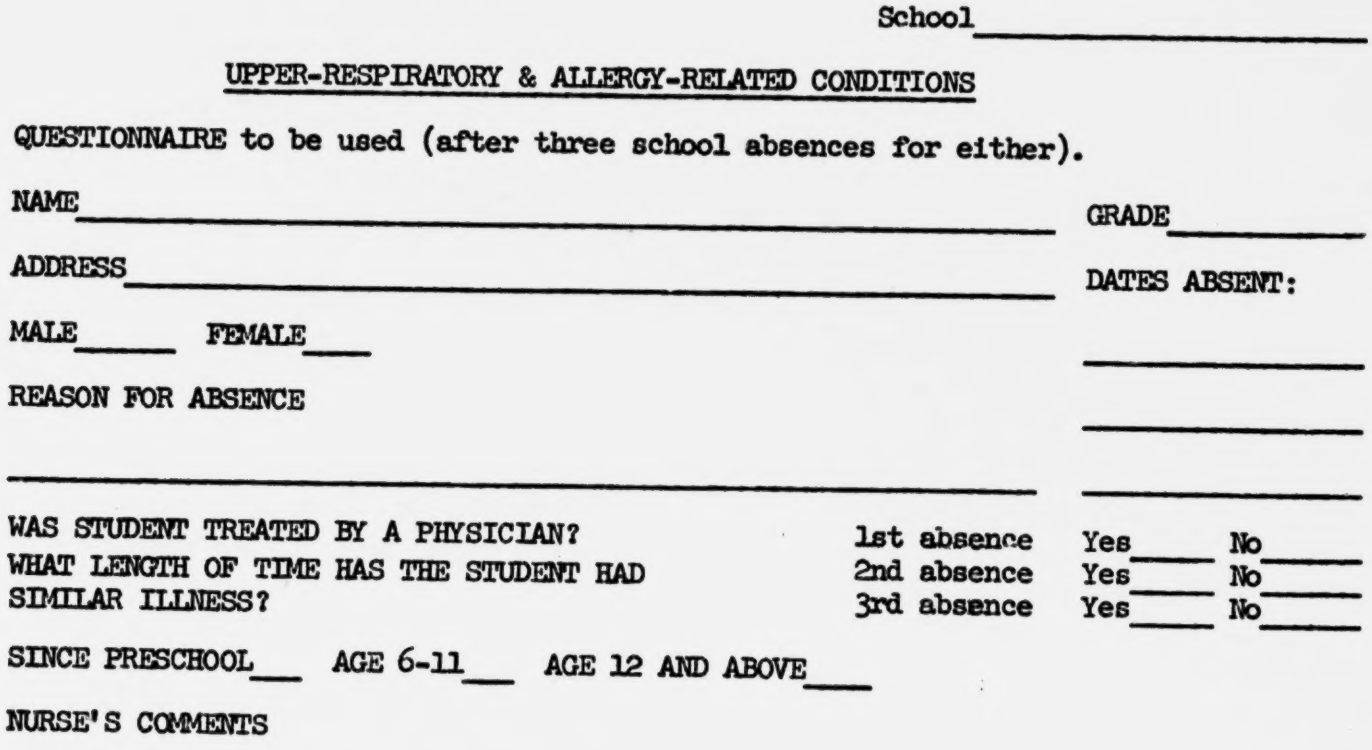
Reason

C - Cut, Scratch, Bruise
H - Headache
T - Toothache
E - Earache
S - Sprain or Break
F - Unusual Temperature
U - Upset Stomach
W - Tired, Sleepy
N - Nosebleed
B - Cramps
O - Other

Disposition

H - Taken home by parent
R - Returned to classroom
D - Taken to hospital or physician's office
K - Kept in clinic room
O - Other (write out explanation)

Students who might be chronically afflicted by upper respiratory and allergy-related conditions were made the subjects of a special record, Figure X-5. If the readmission slips, or the nurse's observations, indicated that such illnesses had been the cause of three absences, the special record was made. The form provided space for a statement of the reason, i. e., the student's illness; for a record of whether or not he was under a physician's care; for an indication of the duration of his difficulty; and for comments by the nurse.



School____________________

UPPER-RESPIRATORY & ALLERGY-RELATED CONDITIONS

QUESTIONNAIRE to be used (after three school absences for either).

NAME____ GRADE________

ADDRESS______________________________________ DATES ABSENT:

MALE____ FEMALE___

REASON FOR ABSENCE

WAS STUDENT TREATED BY A PHYSICIAN?
WHAT LENGTH OF TIME HAS THE STUDENT HAD SIMILAR ILLNESS?

1st absence Yes____ No____
2nd absence Yes____ No____
3rd absence Yes____ No____

SINCE PRESCHOOL___ AGE 6-11___ AGE 12 AND ABOVE___

NURSE'S COMMENTS

Figure X-5. -- Special Report - Three Absences

The health phase of the total study yielded a body of data, only a part of which related to climate control. The sections of data dealing with health conditions which hypothetically might be related to climatic conditions were analyzed and the results are reported in the next section.

The periods covered in the report are the academic years 1961-62 and 1962-63. It was not possible to institute the study of health conditions during the summer of 1961 because of the shortage of time between the approval of the project and the beginning of that term. An attempt was made to collect health data during the summer of 1962 but the conditions of summer school operation invalidated the data. It was reported in a previous chapter that the summer schools were 30 day periods of half-day instruction. It was the policy of the school that absences were simply not permitted. Visits to the clinic were few, indeed, because the students may have thought that these might be construed as malingering. At any rate, practically all students who may have been indisposed remained in the rooms until noon and then went home without calling their conditions to the attention of the nurses on duty. Such data as were collected were inadequate, unreliable and invalid indicators of the health of summer school students.

B. Contributions of Each of Five Classifications of Illness to Absence

Illness exists in degrees from the very slight to the critical and students in school react to illness in many ways. For a given degree of illness some will immediately seek professional care, others will report to the clinic for a period of rest, and still others will not make their condition known to their fellow students, teachers or nurses. These facts make it necessary to impose arbitrary definitions and decisions in a study of health conditions of students.

For purposes of this study an absence from school for which the parent, nurse or physician gave illness as the reason was accepted as a case of illness in fact. Visits to the school clinic were considered evidence of possible illness, but if such visits were not followed by absence, they were usually unrelated to the classifications of illness with which this study is concerned. Therefore, the study of health conditions is reported in terms of school absences, plus a gross enumeration of clinic visits as an indicator of the health of students while present in school.

All analyses of absences are reported in terms of the number per hundred students in average daily membership during the period covered. The daily membership of a school is defined as the sum of the number of students present plus the number absent for all causes. The average daily membership is the arithmetic mean of the daily memberships for the period covered. The number of students absent per hundred in average daily membership, ADM, is a statistic in terms of which comparisons may be made between schools, between months and between classifications of illness. This statistic was therefore used in these analyses.

The reader will recall that all school absences were classified under eighteen major headings (Figure X-1). Five main classifications were of interest in this study: Upper Respiratory, Communicable Diseases, Skin Diseases, Gastro-Intestinal, and Non-Specific. Illnesses reported, grouped under these five classifications, were given as the principal causes of all absences in each school. The general level of school absences and the relative importance of illnesses in the above mentioned five classifications are shown in Table X-1.

Table X-1. -- Mean Monthly Absence Rates per 100 Students for Each of Three Categories of Absence.

	Oak Grove		Pinellas Park		Tyrone	
	1961-62	1962-63	1961-62	1962-63	1961-62	1962-63
All Absences	4.38	3.99	6.13	6.11	4.62	3.86
Five Classifications	3.74	3.33	5.04	4.54	4.03	3.31
All Other Categories	.64	.66	1.29	1.57	.59	.55

The data in this table show that the rates of absences do not differ appreciably between Oak Grove and Tyrone. The rates of all absences at Pinellas Park are approximately 1.9 per hundred greater than in either of the other schools. Over the two year period, the rate of all absences at Pinellas Park is more than 30% greater than at either of the other schools. An inspection of the data for the five classifications of illnesses indicates that these contributed about equally to the absences at Oak Grove and Tyrone and that they accounted for proportionately more at Pinellas Park than at either of the other schools. The same general relationships were obtained among the schools with respect to absences in all other categories.

The reader will recall that data have been reported in preceding chapters which indicate that Pinellas Park served a community whose socio-economic level was below that of the other two schools. By averaging the rates for the two years at each school and computing the proportion of the average of the total absence rates contributed by absences from all causes other than the five under consideration, one may conclude that absences under "Remaining Reasons" are relatively more important at Pinellas Park than at either of the other two schools.

The incidence of certain of the diseases subsumed under the five classifications also tends to be higher among students at the lower socio-economic levels than among those at the higher. At given degrees of severity of an illness the students at Pinellas Park also may have manifested a greater tendency to be absent than did those at either of the other schools. If this is true, absence as a measure of the incidence of illness inflated the data for Pinellas Park. These considerations suggest that the observed differences between Pinellas Park and the other two schools with respect to the rates of absence attributed to illnesses under the five classifications under study are not due wholly to differences between school facilities but are due at least in part to differences in socio-economic levels.

The distributions of the rates of absences by months were also examined. The data in Table X-2 report the number of students absent per 100 in ADM for each of the school months of the academic year 1961-62. The data are reported by schools for: 1. All Absences; 2. Upper Respiratory Illnesses; 3. Communicable Diseases; 4. Skin Diseases; 5. Gastro-Intestinal Illnesses; 6. Non-Specific Illnesses; and 7. Remaining Reasons. The data for the year 1962-63 are reported in Table X-3, which is similar in form and organization. The data in these tables are represented graphically and evaluated on the basis of the relationships shown.

Table X-2. -- Monthly Rates of Absence per 100 Students in Average Daily Membership for All Reasons and for Specified Classifications of Illness. Oak Grove, Pinellas Park and Tyrone, 1961-1962.

Reason for Absence	School	Months								
		Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May
All Reasons	OG	1.96	3.17	2.79	3.66	10.56	5.06	4.43	4.13	3.70
	PP	2.38	4.32	5.12	5.56	13.55	6.76	5.77	6.38	5.41
	Ty	2.36	3.19	2.73	3.58	11.19	5.68	4.96	4.49	3.46
Upper Respiratory	OG	.61	1.81	1.23	2.13	8.65	3.81	2.59	2.31	1.15
	PP	1.31	1.94	2.19	2.69	11.68	3.90	2.71	3.26	1.87
	Ty	1.12	2.02	1.06	1.92	9.29	4.20	3.20	2.65	1.37
Communicable Diseases	OG	.02	.08	-	.03	-	-	.04	-	.07
	PP	-	.02	.06	.15	.02	.04	.12	.08	.08
	Ty	.07	.04	.04	.02	.04	-	.16	.08	.03
Skin Diseases	OG	.01	.01	-	-	.02	.01	.06	.03	.01
	PP	.10	.14	.07	.20	.12	.13	.12	.03	.04
	Ty	.07	.08	.11	.04	.07	.05	.06	.16	.16
Gastro-Intestinal	OG	.16	.36	.45	.40	.55	.36	.47	.53	.62
	PP	.27	.57	.55	.70	.59	.70	.89	.97	.96
	Ty	.17	.40	.39	.44	.60	.44	.44	.49	.61
Non-Specific Illnesses	OG	.24	.25	.46	.49	.77	.44	.73	.74	.92
	PP	.17	.45	.43	.44	.54	.44	.58	.59	.67
	Ty	.32	.34	.46	.39	.70	.44	.47	.55	.51
Remaining Reasons	OG	.92	.66	.65	.61	.57	.44	.54	.52	.93
	PP	.53	1.20	1.82	1.38	.60	1.55	1.35	1.45	1.79
	Ty	.61	.31	.67	.77	.49	.55	.63	.56	.78

Table X-3.-- Monthly Rates of Absence per 100 Students in Average Daily Membership for All Reasons and for Specified Classifications of Illnesses. Oak Grove, Pinellas Park and Tyrone, 1962-63.

Reason for Absence	School	Months								
		Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May
All Reasons	OG	1.73	2.73	3.70	4.45	3.87	5.64	5.38	3.95	4.52
	PP	2.89	3.82	6.35	7.58	7.08	8.60	7.32	5.79	5.56
	Ty	1.93	2.68	4.19	4.70	3.55	5.24	6.16	3.54	2.84
Upper Respiratory	OG	.90	1.37	2.88	2.62	2.03	3.09	3.22	1.65	1.83
	PP	1.23	1.82	3.60	4.20	3.40	4.77	3.77	1.82	1.83
	Ty	1.08	1.43	3.04	3.40	2.24	3.62	4.54	1.75	1.35
Communicable Diseases	OG	.03	-	-	.04	.09	.12	.22	.33	.47
	PP	.03	-	.21	.30	.29	.43	.34	.19	.11
	Ty	-	.04	.02	.04	.02	.25	.19	.15	.08
Skin Diseases	OG	.03	.03	.06	.07	.02	.16	-	.08	.03
	PP	.03	.05	.16	-	.07	.05	.12	.09	.15
	Ty	.04	.05	.04	.08	.07	-	.06	.08	.07
Gastro-Intestinal	OG	.19	.42	.49	.49	.76	.52	.66	.69	.57
	PP	.32	.48	.74	.87	.75	.92	.83	.80	.97
	Ty	.26	.26	.22	.39	.46	.35	.56	.35	.33
Non-Specific Illinesses	OG	.28	.37	.27	.29	.33	.56	.50	.44	.77
	PP	.30	.41	.41	.58	.38	.60	.66	.91	.77
	Ty	.25	.27	.36	.19	.21	.43	.36	.44	.45
Remaining Reasons	OG	.30	.54	.00	.94	.64	1.19	.78	.76	.85
	PP	.98	1.06	1.23	1.63	2.19	1.83	1.60	1.98	1.73
	Ty	.30	.63	.51	.60	.55	.59	.45	.77	.56

The distribution of monthly rates of all absences in each school for each year is shown in Figure X-6. During both years the rates in Oak Grove and in Tyrone differed by relatively small amounts each month; hence the forms of their distributions were quite similar. The rate of absences at Pinellas Park was consistently greater than for either of the other two schools. There is a marked tendency for absentee rates of all schools to be minimal in September, to increase to peak rates during the winter months and to decrease with the coming of spring in March or April. These figures indicate that there was no period during the two years under study in which the rates of absenteeism in Oak Grove were distinctively different from those in Tyrone, a non-climate controlled school. The position of Pinellas Park suggests that its monthly rate is an almost constant non-linear function of the rate at either of the other two schools. These analyses do not suggest that climate control exercised a distinctive influence upon the rates of absence in these schools.

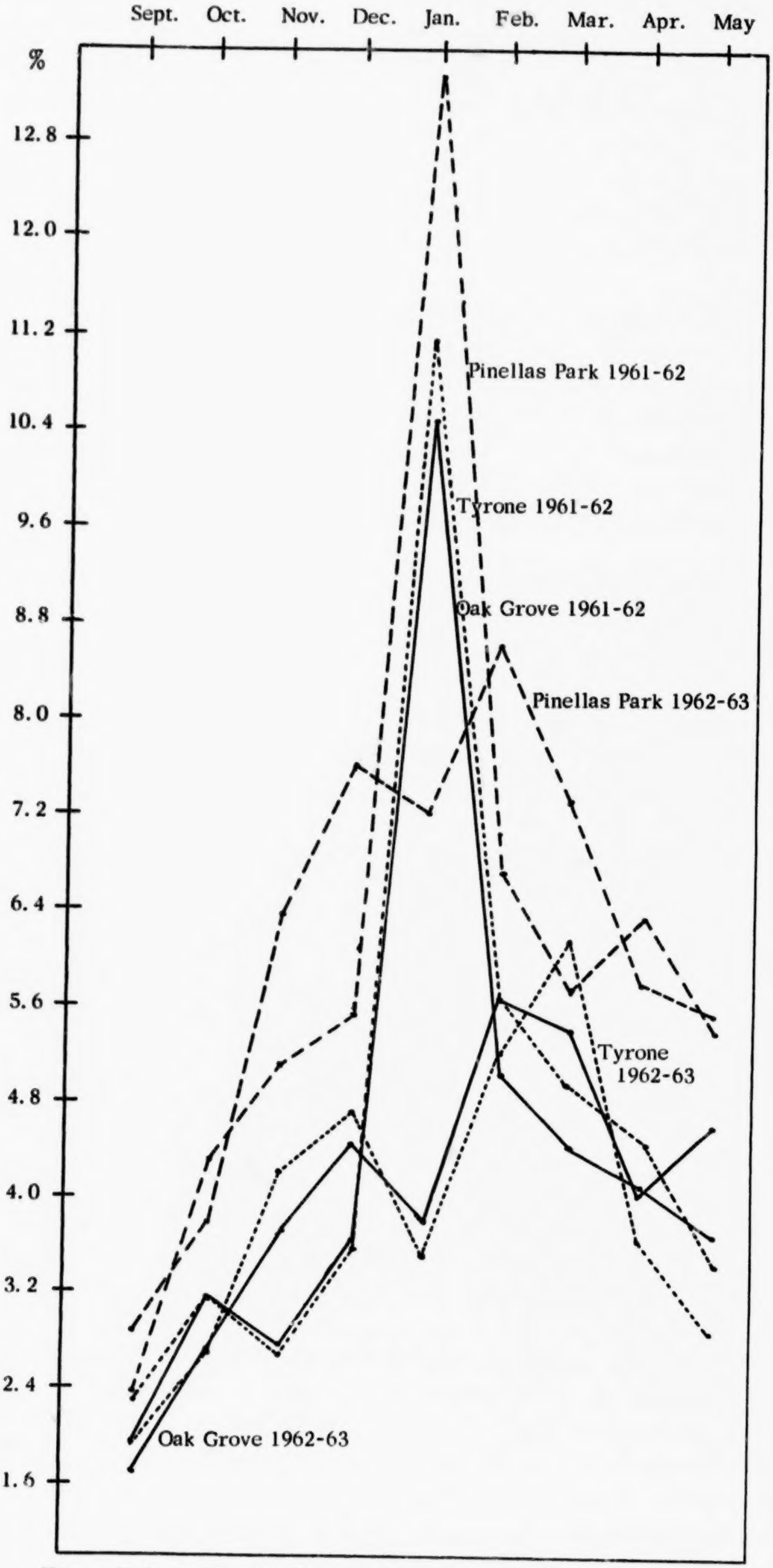


Figure X-6. -- Monthly Absence Rates of Each School for Each Year, 1961-62 and 1962-63.

The data reporting monthly rates of absences for which upper respiratory illnesses were given as the cause are represented in Figure X-7 for 1961-62 and 1962-63. The forms of the distributions represented in Figure X-7 are strikingly similar to those shown in Figure X-6 for the same year. During 1961-62, the absolute differences between pairs of schools each month were small. Pinellas Park at no time had the lowest rate. At times the rate at Oak Grove was lower than at Tyrone, and at other times the reverse was true.

The 1962-63 data suggest that there were two epidemic periods of upper respiratory illnesses. The first was experienced in all three schools in November and December, and the second in February and March. The increases during these periods were least in the Oak Grove school and greatest in Pinellas Park. Tyrone tended to occupy a position intermediate between the climate controlled school and Pinellas Park, the other non-climate controlled school.

These analyses of the monthly rates of absences attributed to upper respiratory ailments indicate that the rates in the climate controlled building were generally as low, or lower, than those in Tyrone and quite consistently lower than those in Pinellas Park. They also offer no support for the hypothesis that the circulation of air in the climate controlled school would produce epidemic patterns substantially different from those experienced in buildings in which mechanical circulation was not provided.

The data on rates of absences attributed to communicable diseases are presented graphically in Figures X-8 and X-9 for the years 1961-62 and 1962-63, respectively. The rates are relatively low, the largest being less than 6 per thousand students in average daily membership. During the first year, the differences were so small that valid distinctions cannot be made. During the second year, the pattern of the incidence of communicable diseases suggests the normal curve in Pinellas Park. Communicable diseases entered the climate controlled school later and the rate of absences resulting seems to have followed a slowly accelerating curve to the close of school. Tyrone was the most favored of the schools with respect to the rates of absences attributed to communicable diseases. Because of the relatively low rates in each school of absence attributed to communicable diseases, it is doubtful that the reported differences are of material significance.

The data on monthly rates of absences attributed to skin diseases are presented graphically in Figures X-10 and X-11 for the years 1961-62 and 1962-63, respectively. All rates are low, the highest being two per thousand students in average daily membership. Actually the rates indicate that from 0 to 3 students were so afflicted in each school each month. At these rates, no significant differences between schools can be expected. Certainly, there is no pattern that is peculiar to the climate controlled school or to either or both non-climate controlled schools.

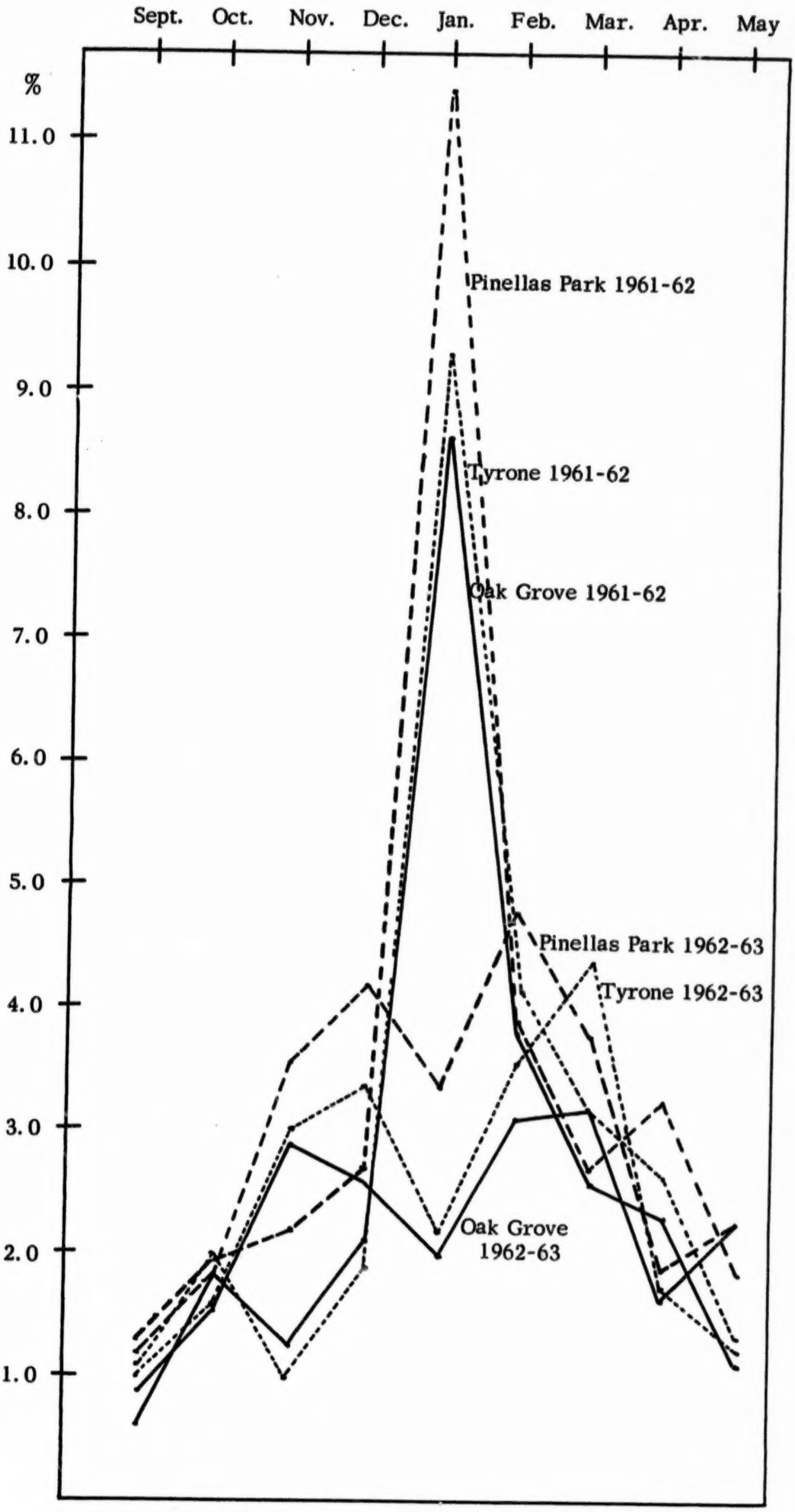


Figure X-7. -- Monthly Rates of Absence Attributed to Upper Respiratory Illnesses, 1961-62 and 1962-63.

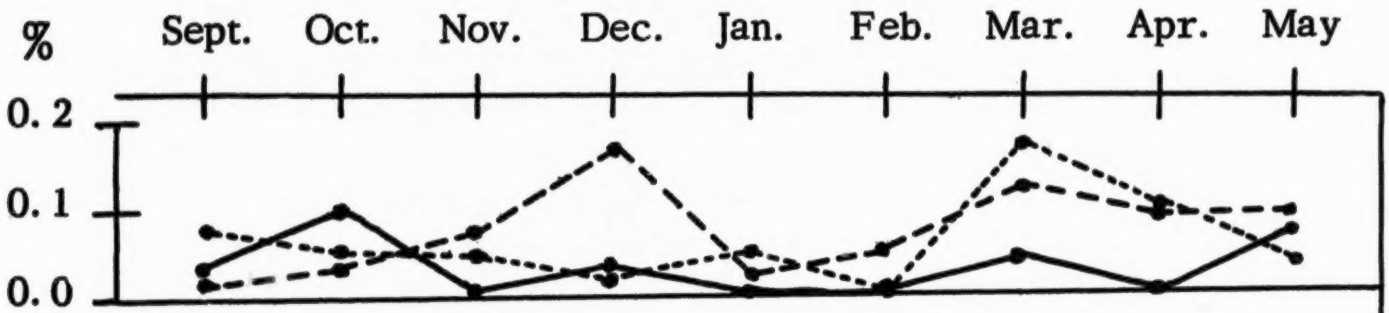


Figure X-8. -- Communicable Diseases, Monthly Rate, 1961-62.

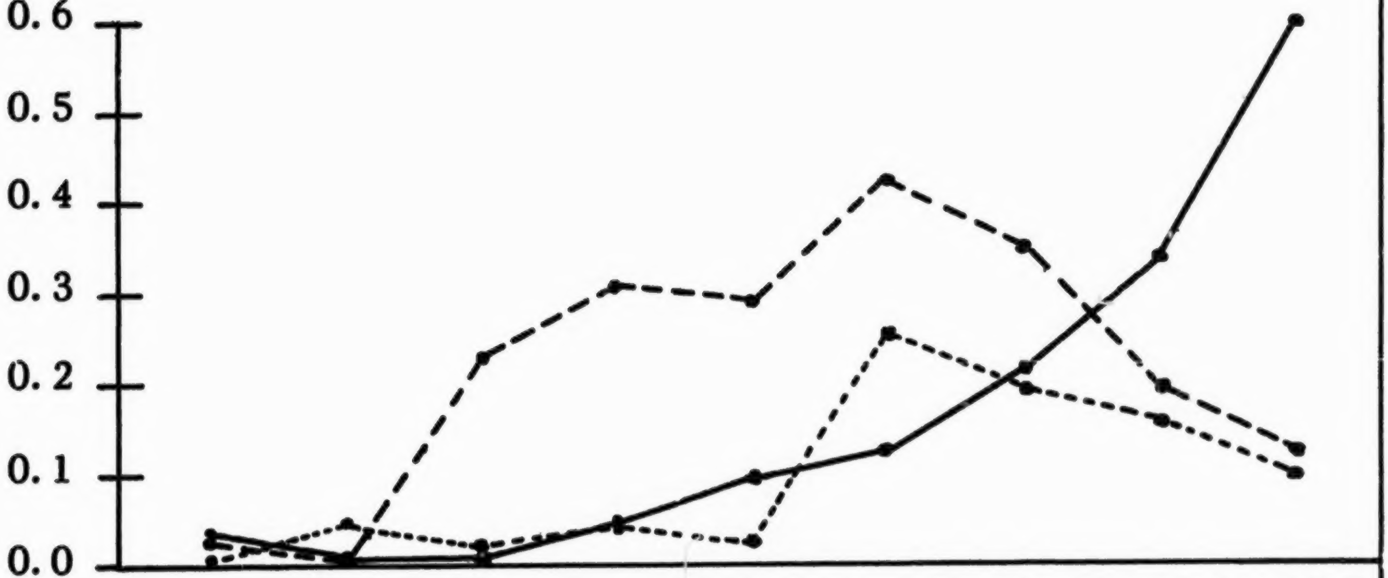


Figure X-9. -- Communicable Diseases, Monthly Rate, 1962-63.

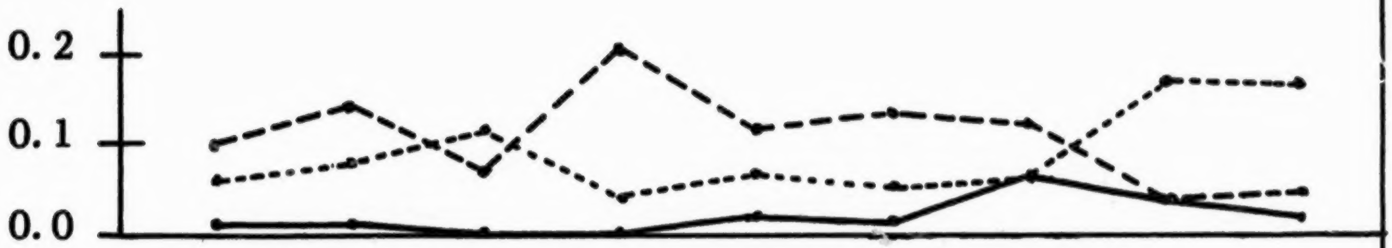


Figure X-10. -- Skin Diseases, Monthly Rate, 1961-62

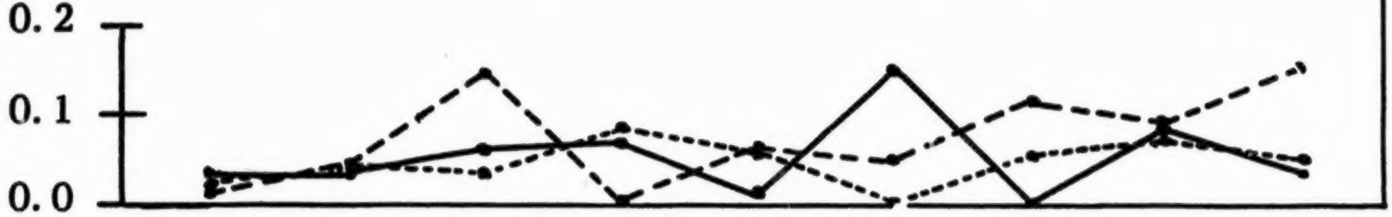


Figure X-11. -- Skin Diseases, Monthly Rate, 1962-63.

Key to Figures above: ——Oak Grove, - - - - Pinellas Park, ----Tyrone

The monthly rates of absences attributed to gastro-intestinal illness are presented graphically in Figures X-12 and X-13 for 1961-62 and 1962-63, respectively. With the exception of the month of January each year, the rate at Pinellas Park was higher each month than that in either of the other schools. During the first year the differences between Oak Grove and Tyrone were small and inconsistent. During the second year, Oak Grove occupied a position intermediate between Tyrone and Pinellas Park for seven of the nine months. The investigators are unable to suggest a basis upon which the control of climate in the one school but not in the others might account for the similarities and differences shown in these figures.

The distributions of monthly rates of absences attributed to non-specific illnesses are presented in Figures X-14 and X-15. During the first three months of each year the differences among schools were small and their relative positions changed. Starting with December, 1961, the rate at Oak Grove exceeded that of each of the other schools during five of six school months. During this period, the standings of the other two schools shifted in their relationship to each other. The first three months of 1962-63 (Figure X-15) were similar to those of the same period of the preceding year. Starting with December, Oak Grove's position was quite consistently between that of the non-climate controlled schools. The investigators can suggest no basis for ascribing the relationships reported in these data to the presence or absence of air conditioning in the schools.

C. Use of School Clinics

Space in each school was equipped as a clinic. First aid materials were available, cots and chairs were provided, and a nurse or clinic aide was on duty during school hours. Students normally reported to the clinic for the care of minor injuries and as a place of rest when they were slightly indisposed. They also normally reported to the clinic if they were seriously injured or ill. The person in charge then made arrangements necessary for their being taken home or to a hospital or receiving the attention of a physician.

The number of students visiting the clinic is one indicator of the general health conditions of a school. It was assumed that over a period of a month, the visits caused by such things as injuries, toothache, menstrual discomfort, and the like would average out and that variations from month to month would reflect the general state of health of the students. More specifically, the use of the clinic should reflect the effects of conditions which produced mild fatigue, slight headaches, and other indispositions and which were not serious enough to cause the student to be absent from school.

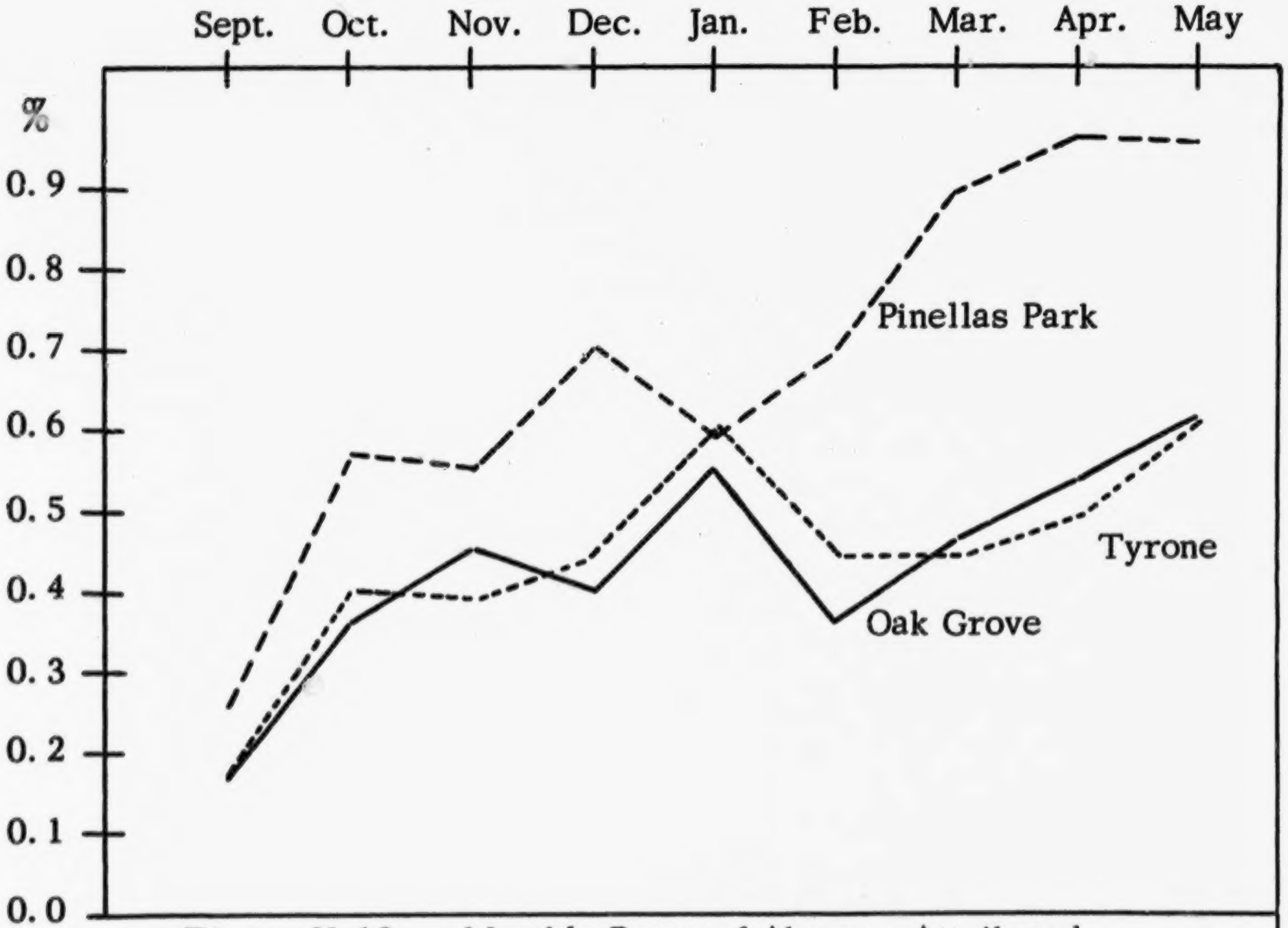


Figure X-12. -- Monthly Rates of Absence Attributed to Gastro-Intestinal Illnesses, 1961-62.

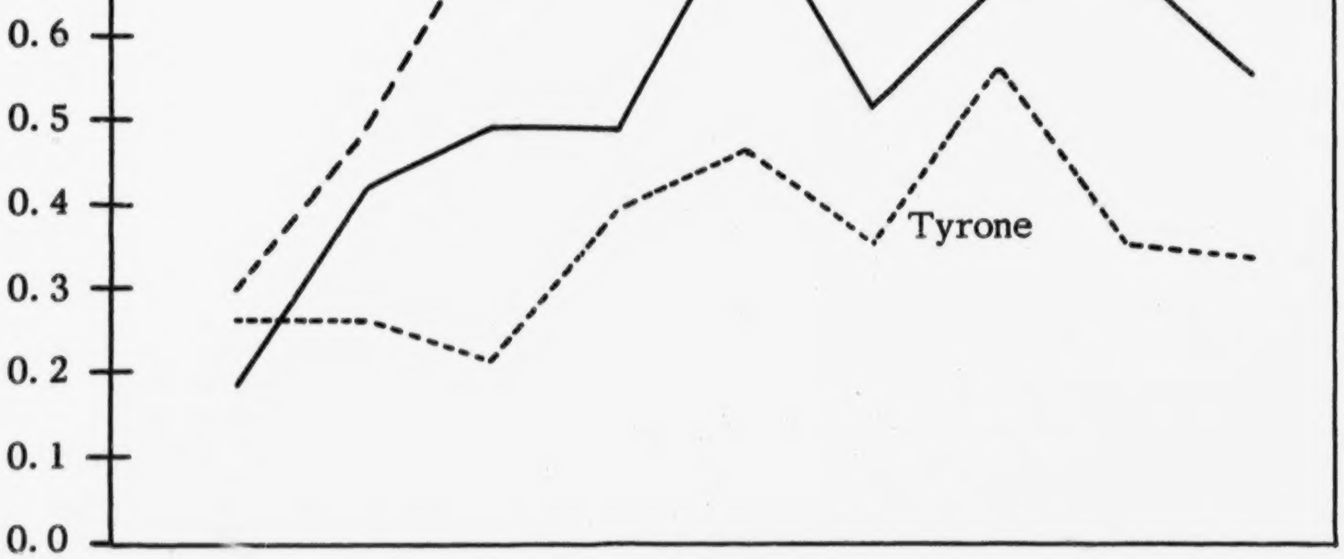


Figure X-13. -- Monthly Rates of Absence Attributed to Gastro-Intestional Illnesses, 1962-63.

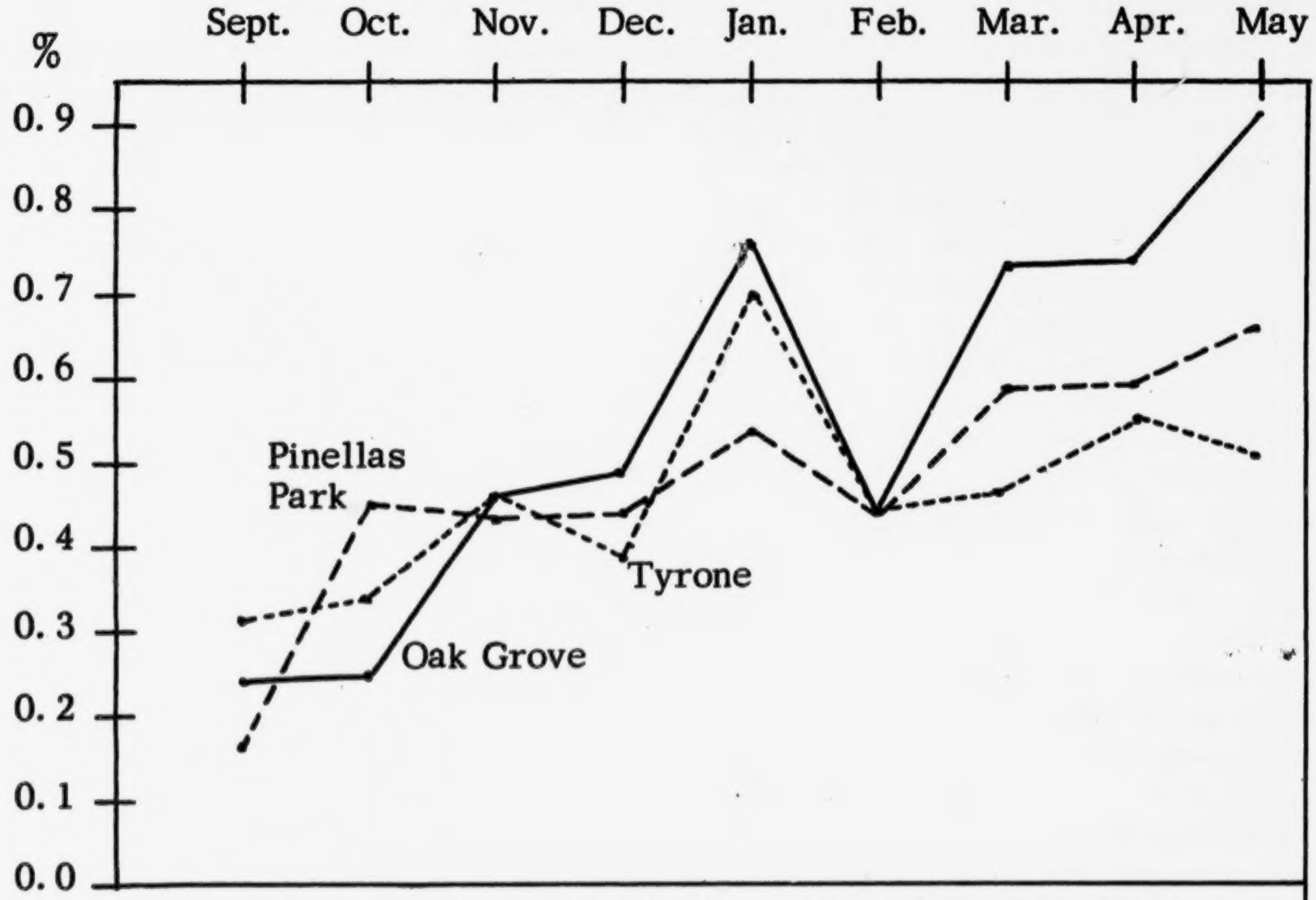


Figure X-14. -- Monthly Rates of Absence Attributed to Non-Specific Illnesses, 1961-62.

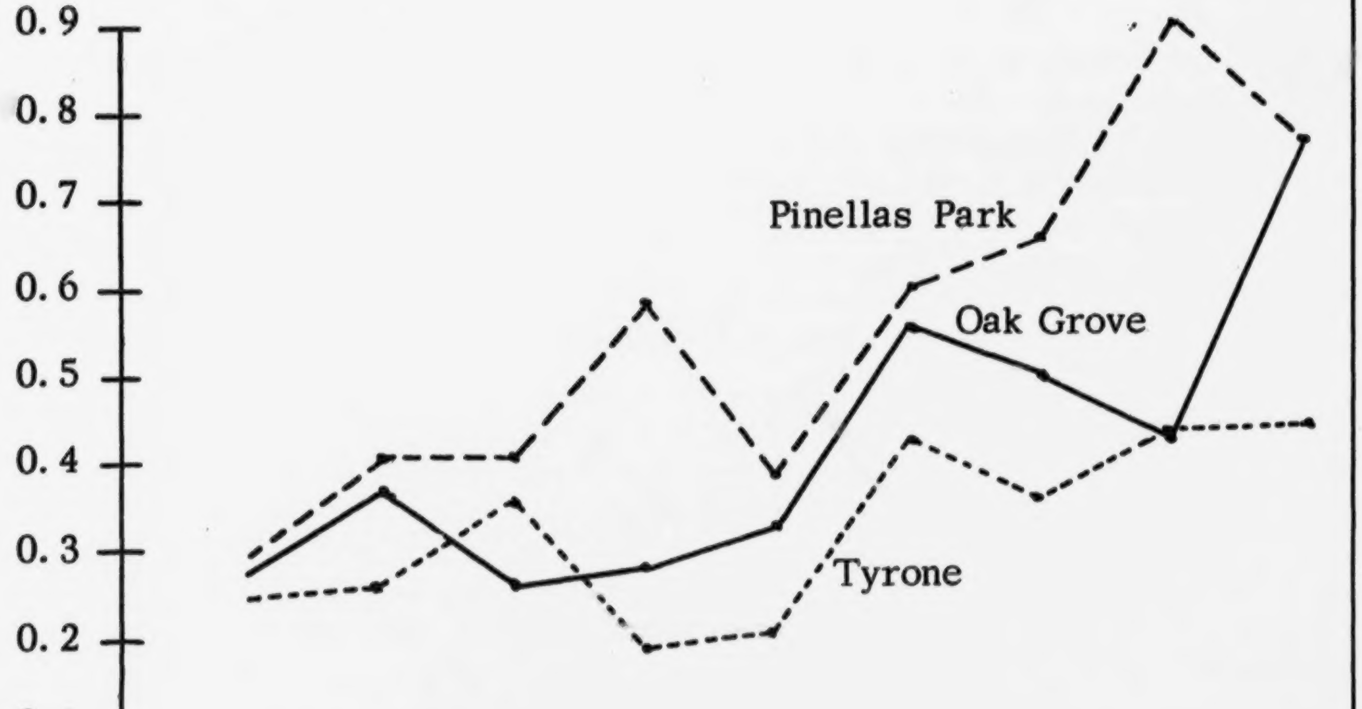


Figure X-15. -- Monthly Rates of Absence Attributed to Non-Specific Illnesses, 1962-63.

The actual use of a school clinic is affected by many factors. By policy or custom in some schools, access to the clinic is free and easy and in others it is used only by students whose condition is relatively serious. In general practice, the students and their teachers have a great deal of leeway in deciding when they, the students, should go to the clinic. Also in general practice, it is necessary for the school principal and the nurse to exercise some surveillance over clinic usage to check abuses of the privilege by students who may be inclined to malinger. In the interpretation of data on clinic visits, these factors tend to reduce the significance of small differences from month to month and between schools.

The distribution by months of the rates of clinic visits for each school are shown in Figure X-16 for the years 1961-62 and 1962-63. The rates are the mean daily number of students per hundred in average daily membership visiting the clinic each month. Rates in Pinellas Park are quite consistently higher than in either of the other schools. This relationship is consistent with the differences in rates of total absences and rates of absences attributed to the classifications which include the more prevalent diseases. The rates at Tyrone increased considerably during the second year over those of the first year, while those at Oak Grove showed little general change. It is possible that a more lenient policy covering clinic usage contributed to Tyrone's shift in position.

Rates of clinic visits tended to peak during those months in which the absence rates peaked. The sharp departures from the general slope of the curve for each school may be explained as the result of the higher incidence of certain illnesses in the schools.

If these peaks may be disregarded, the general properties of the remainder of the curve for Oak Grove for 1961-62 may be expressed as a straight line sloping gently upward. The general properties of the curve for 1962-63 suggest a straight line with perhaps less of an upward slope. The general properties of the curves for Tyrone are very similar to those for Oak Grove. These considerations lead to the conclusion that the control of climate does not affect the clinic usage in a manner substantially different from that experienced in Tyrone.

The distribution for Pinellas Park for 1961-62 appears to have points that are inconsistent with the rates of total absence and the rates of absences attributed to the more important classifications of illnesses. Specifically the relatively low rates for the months of February and March, 1962, may have resulted from policy decisions which reduced freedom of access to the clinic. The remainder of this curve is quite consistent with the other data presented.

With the exception noted above, the curves for the two years may be fairly represented by a straight line sloping somewhat more sharply upward than in either of the other schools. This analysis suggests that the rate of clinic usage each year in Pinellas Park may have increased more rapidly than was true in Oak Grove.

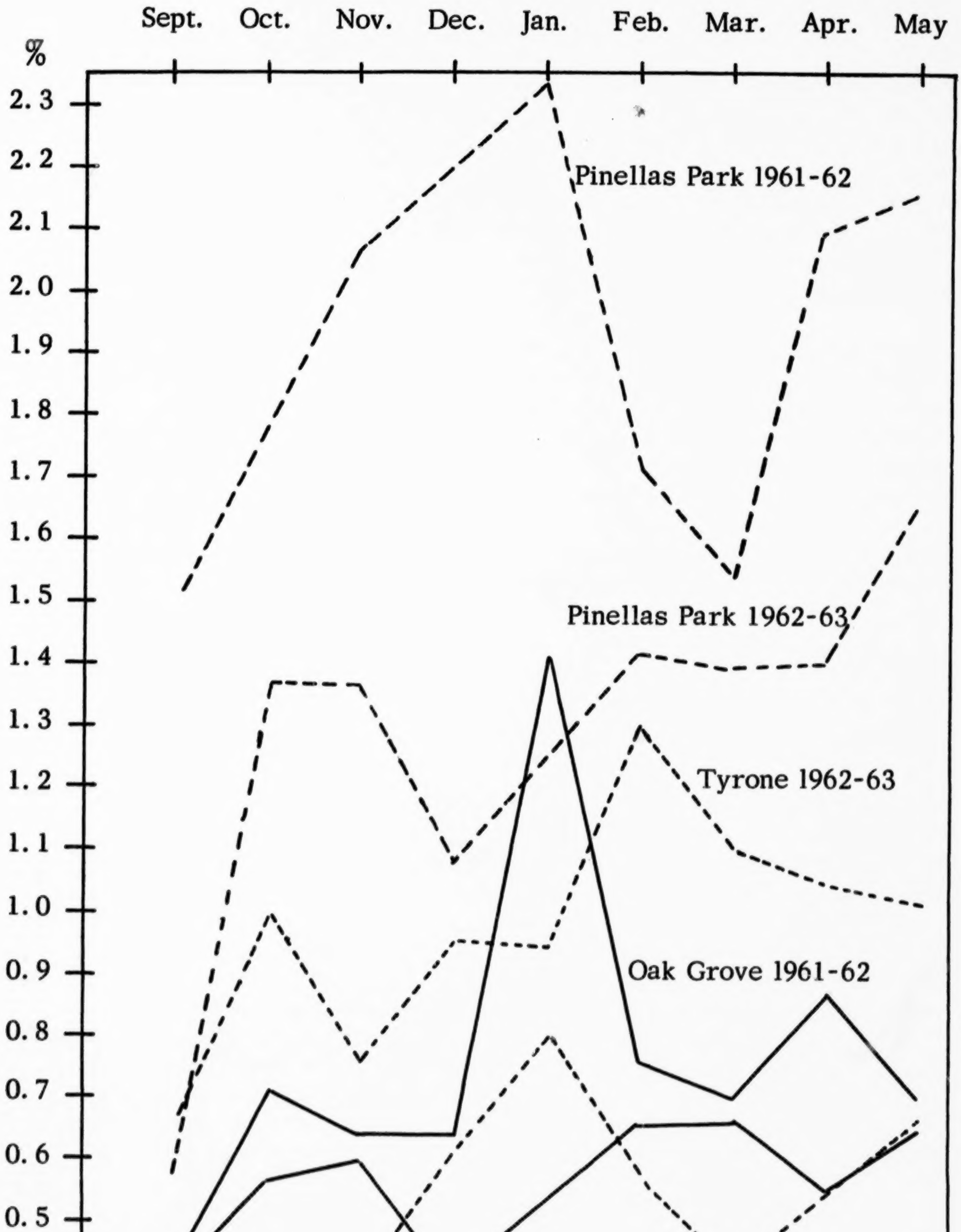


Figure X-16. -- Monthly Rates of Clinic Usage, 1961-62 and 1962-63.

D. Summary and Conclusions

It was the purpose of this study to compare the health of students in Oak Grove, the climate controlled school, with that of students in each of two non-climate controlled schools. The responsibility for the validity of the basic data was that of public health nurses assigned to the project. The measures were the number of absences attributed to each of five major classifications of illnesses and the number of visits to school clinics. The number in each case was converted to the mean daily rate per hundred students in average daily membership per month.

The analyses indicated that the patterns of absences in the climate controlled school, Oak Grove, and in one non-climate controlled school, Tyrone, were generally very similar. There were no differences that were characteristic of fall and spring when one school, Oak Grove, operated on mechanical ventilation and Tyrone opened its windows to the natural flow of outside air.

Rates of absenteeism in Pinellas Park were systematically greater than in Oak Grove. These investigators are inclined to attribute these differences to the difference in the socio-economic levels of communities served by these schools. Had there been differences which were more highly characteristic of fall and spring than of the cool months, there would have been a logical basis for the inference that the control of climate operated to influence the health of the students.

Analyses also failed to indicate that the ventilating system of the climate controlled school influenced the tempo and pattern of the spread of infectious diseases in a manner substantially different from that occurring in the naturally ventilated schools.

In conclusion, it should be pointed out that the measures employed in this study were not sensitive to the small and possibly very significant differences which may have existed. An adequate study of the health conditions of the students in these schools seemed to require resources which were not available to these investigators.

- - - - - - - - - - - - - - - -

Sections and/or chapters of this report have been summarized as they were presented. For a general and brief summary see the digest bound into the front of this report. Copies of the digest may be obtained separately.